

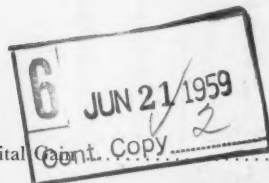
Sci. Bibl.

6/15/59

SCIENCE

12 June 1959

Volume 129, Number 336



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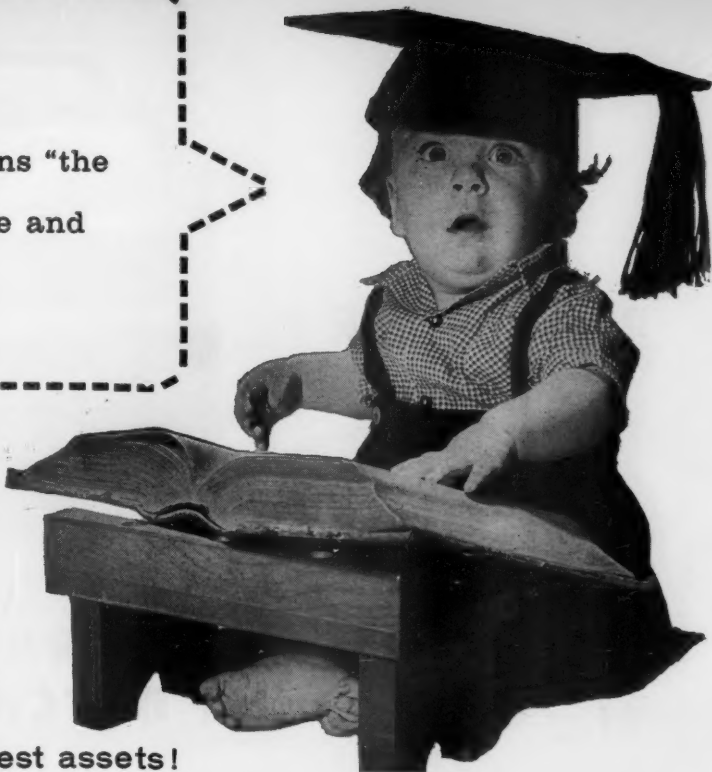
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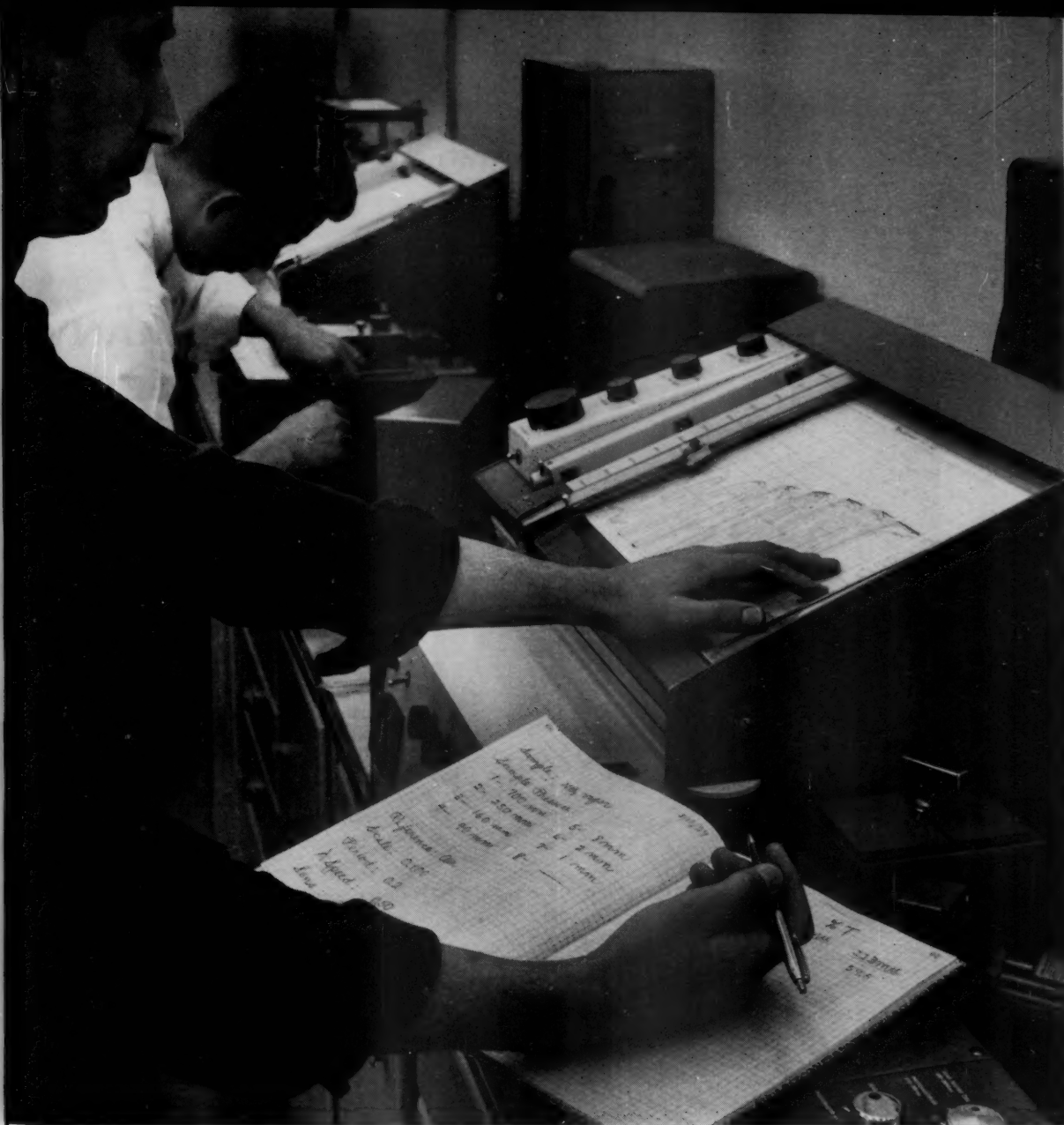


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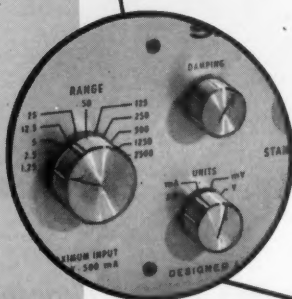
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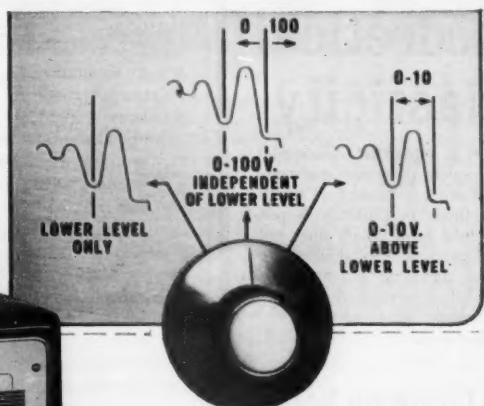
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Letters

Science in Israel

The two recent editorials dealing with science in Israel [*Science* 129, 869, 995 (1959)] have special interest to me, since, as a U.N. Technical Assistance consultant in Israel twice, I was involved in certain aspects of the problems described. I offer a personal opinion concerning particularly the second editorial, "Basic research a luxury?" I feel that the editorial exaggerates somewhat the actual differences in viewpoint which exist, and that it states the argument from a rather unrealistic point of view.

Fundamentally, I believe the question is not whether basic research is either a dispensable luxury or a vital necessity in Israel today, or even whether applied research should prevail at the expense of the basic. What is pertinent is the question of balance between the two, taking into account the fact that Israel is a small country of limited natural resources, suffering from stringent economic problems brought on by both heavy immigrant absorption and large but necessary outlays for national defense. Despite rumors to the contrary, Israel simply does not have at this time a sufficient number of adequately trained and seasoned scientists to meet all of the present demands for both basic and applied research. Thus, to some observers in and out of Israel, including myself, the greatest urgency at this particular moment is maximum effort in technological development. While the vital importance of maintaining as much basic and long-range research as the economy can support is not denied, nevertheless the country is limited in its total scientific resources.

Actually, the problem touched on has deeper sociological and emotional roots than the editorials indicate. The source of Israeli science lies in the older European tradition which rewards, with social and intellectual status, individuals identified with basic research. This attitude is rapidly disappearing in Israel, but one continues to meet it there frequently enough to comprehend its major formative influence on the intellectual values and career orientation of students entering scientific fields.

Finally, the editorial discussion of science in Israel might have pointed up a growing problem of major concern not only to Israel but also to a number of European countries as well. I refer to the extent to which these scientifically literate countries are being "raided" for scientific and technical talent by the United States. As a consequence, a serious threat appears to be developing not only to the scientific, academic, and technical welfare of these small countries

themselves but, in the longer range, also to the vital interest which the United States has in the survival and strengthening of these democratic outposts.

It seems to me that the various United States governmental agencies responsible for allocating ever-increasing sums for research within the United States, should show greater concern for the fact that they may be heedlessly, but nevertheless seriously, weakening the scientific fiber of the smaller nations. A leading Israeli scientist made the point to me that the interests of the United States might be better served if a real effort were made to place U.S. Government projects for nonsensitive or nonclassified types of research in countries with capable scientists, such as Israel and several European and Asiatic countries whose survival is vital to our interests. Such a program would not only yield substantial savings in research costs but would also permit these countries to improve and expand their scientific and academic institutions.

A start has already been made in this direction by the U.S. Department of Agriculture, by allocating to research in several countries, including Israel, local currencies accumulating there by purchases of U.S. agricultural surpluses (Public Law 480). It seems to me that this small beginning could be expanded to the mutual advantage of the United States and democratic countries such as Israel whose welfare and survival concern us.

MAX MILNER

Kansas State University of
Agriculture and Applied Science,
Manhattan, Kansas

Mating for "Hybrid Vigor"

In his report "Hetero blood types and breeding performance," Mogens Plum [*Science* 129, 781 (1959)], in discussing his data on the matings between 310 females and 32 males of the Holstein-Friesian breed, states, "The rate of survival increased as the difference in antigens increased. The chi-square of 8.72 is significant at 0.05 level." This chi-square of 8.72 is what might be termed the total chi-square for his data and is based on 3 degrees of freedom.

It is possible, of course, to calculate, from the data Plum gives in Table 1, three values of chi-square, based on a single degree of freedom each, which will add to 8.72. On the basis of the number of antigens in which mates differed, the following independent comparisons or degrees of freedom might be used: 1-5 versus 6-7, 1-5 plus 6-7 versus 8-9, and 1-5 plus 6-7 plus 8-9 versus 10-15. These comparisons and their chi-squares, together with other pertinent information, are given in the following table.

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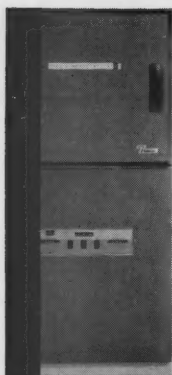
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Summary of detailed chi-square analysis of data on matings between 310 females and 32 males of Holstein-Friesian breed, presented by M. Plum.

Comparison	D/F	Sum of squares	Factor	χ^2	p^*
1-5 vs. 6-7	1	0.1675	4	0.670	NS*
1-5 + 6-7 vs. 8-9	1	0.0618	4	0.247	NS*
1-5 + 6-7 + 8-9 vs. 10-15	1	1.9511	4	7.804	.01
Total	3	2.1804	4	8.721	.05

* Level of significance; NS, not significant.

The results presented in this table indicate that, if dissimilarity of blood antigens may be used as a guide for mating for "hybrid vigor," the number of antigens in which mates differ must be equal to or greater than some minimal or threshold number of a given group of breeding animals in order to achieve the desired effect.

A. E. BRANDT

Department of Statistics,
Agricultural Experiment Stations,
University of Florida, Gainesville

Using Theses for Scientific Communication

The increasingly critical problem of space limitation in scientific communication has recently received attention in *Science* editorials [*Science* 127, 623, 1145 (1958)] and comments [127, 1458 (1958); 128, 424 (1958); 129, 118 (1959)]. Among the suggested solutions, the publication of journals in microform, the appearance of articles in abstract, and the availability of photocopies of desired manuscripts have all been advanced singly or in combination.

A letter by Phipps [*Science* 129, 118 (1959)] is of especial interest because six attributes of a system for improvements in publication communicability are presented. He applied his criteria, however, to a seemingly radical departure from current practices, involving abridged articles, abstract cards, and photocopies. Although his standards were developed as a test for a hypothetical system of journal publication, most of the criteria can be used to evaluate a suggestion that I wish to propose as a more conservative method for overcoming space limitations in professional journals. The criteria are: (i) capability of evolving from the existing system; (ii) reduction of delays in communicating results; (iii) coverage of a broad range of scientific interests (reversal of the trend toward overspecialized journals); (iv) guarantee of self-determination to the individual author (elimination of editor-referee censorial power and of pressure toward abridgment of source material); (v) guarantee of self-deter-

mination to the individual subscriber; (vi) incurrence of no added cost.

The procedure to be indicated would seem to be of greatest value for an explanation in full of a methodological approach or theoretical system. It might have been used advantageously by one learning theorist who replied to critical reactions by saying that they "reflect a serious lack of understanding of the . . . basic theoretical framework . . ." (1). (Part of this lack of understanding was ascribed to an inadequate treatment which resulted from space limitations in journals, allowing only a brief and piecemeal theoretical discussion.) I used this procedure to advantage when I designed a series of experiments investigating the comparability of a pictureless Thematic Apperception Test (2) to the standard version (3). To insure objectivity in these comparisons, I compiled a scoring manual, involving some half dozen scales and full illustrative protocols indicating their application (4). While dittoed copies were prepared to be sent to interested scholars, copies will also be bound as appendixes in theses of graduate students in Virginia and Texas who are making use of them. Such binding insures scholarly permanence and availability on interlibrary loan should my supply become unavailable. In addition, this use of theses for scientific communication seems to meet four of Phipps criteria. For, it (i) is part of the existing system, (ii) reduces delays in communicating information, (iii) guarantees complete self-determination to individual authors (the cost of duplicating manuscript pages is but a minuscule fraction of the charges for printing them), (iv) involves no added cost. The two criteria not met are inapplicable. Furthermore, employment of the thesis as a medium for scientific communication may increase its audience and certainly serves to insure completeness. The former is desirable; the latter is recommended (5).

Without change in journal policy one may insure the full availability of material regarded as important, or, at least, used by fledgling researchers in their formulations. Theses are seldom in the forefront of tools available to all scholars, nor are they all indexed even as whole items. Hence when a person whose material is inserted in a thesis writes a journal article that concerns the subject treated in the inserted material, it behooves him to include in his article a reference to the thesis repository. Without such specific citation, the theoretical or methodological addendum might not become a part of the literature. More than a few people must know where the material is obtainable.

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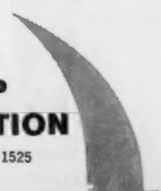
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to insure its location when requested by readers of the article. The form of reference 4, below, is within the style of references appearing in *Science*, and could be easily adapted to editorial policies of other scientific bodies. If the material is bound in more than one thesis, as will be the present case, the writer might cite the copy available in the library more frequently used by his colleagues, or the one best equipped for rapid interlibrary loan, or, if he is associated with an academic institution himself, prestige considerations might dictate citation of his college library.

The use of graduate theses for scientific communication would seem to be a partial but satisfactory solution to the problem of diminished space and expanded output. Such usage might be welcomed by those who may need to familiarize themselves with the insert in only one such thesis for full background information on a series of journal publications. Journal space is scarce, ingenuity is not.

DELL LEO

Child Guidance and Speech Correction Clinic, Jacksonville, Florida

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"Feedback" in Evolution

In his review of *Behavior and Evolution* (Anne Roe and George G. Simpson, Eds.), C. H. Waddington [*Science* 129, 203 (1959)] discusses the lack of emphasis by the several authors on the "various types of 'feedback' or circularity in the relation between an animal and its environment." He says that the relation of the behavior of an animal to the evolutionary process is not solely that of a product, but is also one of the factors which determines the magnitude and type of evolutionary pressure to which the animal will be subjected. Behavior is at the same time a producer of evolutionary change as well as a resultant of it.

In his recent articles, and particularly in his recent book *The Strategy of the Genes* (1957), Waddington has clearly demonstrated "genetic substitution" by means of evolutionary feedback through natural selection. I agree with Waddington that this process is important for an understanding of much adaptive evolution, including the evolution of adaptive behavior. However, in his book

review, Waddington seems to have missed my discussion (pp. 319, 323, 331), which is in essential agreement with the point of view expressed by Waddington in his criticism, and which he says did not "emerge completely into the light of day." For the feedback from behavior to isolating mechanisms, a process that Waddington feels did not receive sufficient emphasis in the chapter by H. T. Spieth, I should also like to call attention to *Principles of Animal Ecology* (1949), by Allee, Emerson, Park, Park, and Schmidt, for a discussion of this point (pp. 619, 630, 695).

ALFRED E. EMERSON

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It was only the feeling that my review was already unduly long that prevented me from giving references to the few remarks, such as those in Emerson's interesting paper, which referred to "feedback" relationships in evolution. The passage in which I expressed a wish to have heard more about such matters was not so much a criticism as it was a comment prompted by the British convention that no review, however favorable, should suggest that a book is quite incapable of being improved. After all, "feedback" is, at least in connection with biology, a rather vague concept; I still think it requires a good deal more discussion and experiment than has yet been devoted to it.

C. H. WADDINGTON

*Institute of Animal Genetics,
University of Edinburgh*

Biological Bromination

In the 20 March issue of *Science* [129, 778 (1959)], J. W. Burger and Ti Li Loo give an interesting account of bromination of phenol red by the dogfish. However, they state that there appears to be no recorded instance of bromine being incorporated into an experimentally introduced exogenous material. Attention is invited to the fact that we have shown [*Proc. Soc. Exptl. Biol. Med.* 80, 241 (1952)] that dibromindigo appears in the urine of rats after intragastric injections of hexabromostearic acid.

J. F. MCCLENDON,
J. GERSHON-COHEN

*Department of Radiology,
Albert Einstein Medical Center,
Philadelphia, Pennsylvania*

We thank McCleendon and Gershon-Cohen for bringing their article to our attention.

J. WENDELL BURGER

Trinity College

TI LI LOO

National Cancer Institute

SCIENCE, VOL. 129

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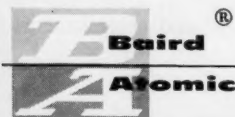
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Capital Gain

Last month President Eisenhower approved a report setting forth a comprehensive plan for greatly increasing the federal investment in high-energy nuclear research. The report recommends that government funds for the construction and operation of accelerators be increased from \$59 million for fiscal year 1959 to \$135 million for fiscal year 1963, with the Atomic Energy Commission, the Department of Defense, and the National Science Foundation as the principal agencies involved. The report was prepared by a special panel appointed by the President's Science Advisory Committee and the General Advisory Committee to the Atomic Energy Commission. Increased investment in nuclear research is most welcome, and our only regret is that approval for such a plan did not come earlier.

If this country is to continue to advance in nuclear research, considerable federal support is necessary, for the cost of modern equipment is too great to be borne by universities or businesses. Indeed, the cost is so great that decisions in the Government concerning its support must be made at the White House level. The report, itself an example of planning at this level, calls for the establishment of an interdepartmental council on high-energy accelerators to continue the panel's work. The council will include policy-level representatives from the Atomic Energy Commission, the Defense Department, and the National Science Foundation. These agencies will continue to be individually responsible for the different research projects, but the council will coordinate their efforts and review new research proposals, including proposals for new accelerators.

Besides coordinating the activities of the agencies doing accelerator physics, the interdepartmental council will be a friend at court helping justify the costs. Until recently the only unit in the administration for reviewing the country's science effort as a whole was one located some distance from this effort: the Bureau of the Budget. Early this year the Federal Council for Science and Technology was established to coordinate the scientific activities of government agencies, and the new council on accelerators presumably will function as a kind of subcommittee of the Federal Council. Advice to budget makers about nuclear research is necessary because in the press of meeting more immediate and obvious demands it is easy to forget that investment in basic research offers a large return to the country, even if that return is on a long-term basis and even if its specific form is unpredictable.

With several federal agencies interested in nuclear research, questions will arise about which agencies should finance which facilities. The report recommends the construction of a linear accelerator at Stanford University, to cost well over \$100 million and to operate eventually at 45 billion electron volts, and it hints that the Defense Department is the appropriate agency in this case. However, as matters now stand, and as stated by President Eisenhower at the recent symposium on basic research at the Rockefeller Institute, the Atomic Energy Commission will be the agency to ask Congress for authorization to finance the accelerator. Any agency doing applied research can benefit from basic research projects, but from the viewpoint of the country as a whole the special security requirements of the Defense Department do not make it the best place for such projects. We take the new assignment of responsibility for the Stanford accelerator as a good sign that the Defense Department's share in nuclear research will be a modest one.—J.T.

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Economic Implications of Urban Growth

This country lacks a public policy to meet the growing problems of dispersed urban settlement.

Coleman Woodbury

In what terms and by what means is urban growth most effectively measured and described? This would seem to be a question basic to any consideration of the topic of this paper. Answering it adequately, however, would require another paper at least as long as this one. Perhaps, therefore, the wise thing to do is to answer it inadequately but quickly and firmly. In this paper, urban growth is indicated largely by population growth. Of course, it has other dimensions such as economic activity, land area, governmental status and services, and the character and complexity of social relationships and interaction. Population growth, however, has obvious advantages for our purposes. We have more data on it than on any other characteristic of urban growth. It is the most commonly used measure. And, as I hope some of the later parts of this paper will make clear, it is unmistakably related to most if not all the other major dimensions of our expanding urban society.

A second fundamental question is—what urban growth? To this the short answer is: current urban growth—the phenomenon largely of the post-World War II years, which in significant respects differs from earlier urban in-

crease, plus whatever modifications we may reasonably anticipate in the short-range future.

Current Urban Growth

One of the most striking characteristics of current urban growth is that it is predominantly metropolitan growth. According to estimates of the Bureau of the Census, for the six-year period 1950 to 1956 nearly 85 percent of the very substantial population growth of the United States (14.7 million) was accounted for by the 168 Standard Metropolitan Areas recognized by the Census of 1950 (1). Only 9.5 percent was independent, that is, nonmetropolitan, urban areas. As to the metropolitan increase, I should emphasize that by no means all of the 85 percent (in fact only slightly more than one-half) was in territory that in 1950 was urban by the principal Census criteria of legal incorporation and density of development. The remainder was largely in parts of metropolitan areas that the Census designated in 1950 as rural nonfarm areas.

On what grounds, then, am I justified in saying that current urban growth is predominantly metropolitan? There are three grounds. First, as the Bureau itself, referring to the rural non-

farm increase in metropolitan areas, has pointed out, "Undoubtedly, much of this increase was in newly developed suburban areas which will be classified as urban in the 1960 Census" (1, p. 1). And I feel sure that the Bureau would agree that if the urban and rural nonfarm parts of metropolitan areas had been marked out in 1956 using the 1950 definitions, the urban area would have much more than half of the six-year metropolitan increase. Second, I suggest that for many purposes the present definition of urban and rural nonfarm territory within metropolitan areas is unfortunate or, perhaps, even misleading. Of course, this is not an unfriendly criticism of the Bureau's terms or work. Its staff members are at least as aware of the difficulties here as anyone else. Certainly, however, many families living within metropolitan areas but in territory now classified as rural are much more like urban families in employment, in their places of shopping, recreation, religious observance, and schooling, and probably in their attitudes, standards, and habits of life than they are like most families in small, relatively independent villages, which are the other major component of the rural nonfarm population. It may be that what is needed is another category for the present rural nonfarm metropolite. And third, if we hold strictly to the current Census definition, the proportion of urban to total population increase is much less, but of the urban increase, about 82 percent is found in metropolitan areas.

It seems to me fair, then, to characterize current urban growth as predominantly metropolitan growth. And in the remainder of this paper I shall be concerned primarily with metropolitan growth.

For purposes of study and discussion, metropolitan areas are often subdivided into the central cities, the suburbs (in Census' terms, the urban territory outside the central cities), and the rural-urban fringe areas (that is, the rural areas—largely rural nonfarm in Census' terms). Population growth from 1950 to 1956 for this breakdown shows another notable fact. Of the six-year *national* increase,

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the central cities accounted for 15.6 percent; the suburbs for 27.2 percent; and the fringe areas for 41.5 percent. For these same classes of areas the rates of increase for this period were: central cities, 4.7 percent; suburbs, 17.0 percent; and the fringe areas, 55.8 percent. Here is evidence of what many thoughtful observers think is a significant redistribution of population, the early stage of a "new pattern of settlement" that, if continued, may prove to be a phenomenon comparable in its economic, political, and social consequences to the great urbanization movement of the latter part of the 19th and the first part of the 20th centuries.

It would be a serious mistake, however, to assume that this redistribution or dispersal of population is a relatively simple phenomenon. It often varies materially from one metropolitan area to another. Furthermore, the broad outlines of it that are indicated by the Census data cited are the net result of a number of other movements or shifts. Although information on these component shifts is not nearly as abundant or as reliable as it should be, a few of them should be examined here.

The large increases in suburban and fringe area populations are, in important part, made up of out-migration from the central cities. Contrary to a fairly common impression, most of this out-migration is not directly from the badly blighted districts of the central cities. It is more than offset by some natural increase plus a substantial in-migration of population—most of it from nonmetropolitan areas and largely composed of Negroes and Puerto Ricans and other whites well down the income scale. Thus, the economically selective character of these shifts in central city populations is bringing them closer and closer to the description applied some years ago by the Regional Plan Association to New York City—the home of the rich, the poor, and the childless.

Suburban newcomers quite clearly include more than their proportionate share of families with young children. In two respects, however, the old image of the suburban community is now false. That image, I believe, was of a dormitory town predominantly of wealthy or very well-to-do people. Suburban communities fitting this description still exist, of course, but more and more suburban in-migrants are in the middle income and some in the lower-middle income ranges. And a recent study of 398 suburban communities of 10,000 or

more showed that only about 46 percent of them, by one standard of measurement, were essentially dormitory towns (2).

About the rural-urban fringes, our knowledge is shamefully weak. Quite probably, however, their inhabitants and current arrivals are a very heterogeneous lot as to income, employment, place of former residence, and standards and ways of life. During the recent house-building boom, apparently more than one-quarter of the national total of nonfarm units produced were built principally by their owners (as distinguished from speculative builders and general contractors), who also became their occupants (3). In large part, this type of house-building is the poor man's response to high construction costs in housing. Quite surely a large proportion of it is taking place in the fringe areas where land is cheap and code standards are low. At or near the other economic extreme is estate-type development, both in the form of new building and, in some areas, rebuilding of older properties. A very few and widely scattered studies indicate that fringe populations are made up not only of migrants from central cities and suburbs plus some indigenous families, many of whose members may now be industrial employees, but also in considerable part of in-migrant families from nonmetropolitan areas, rural and urban.

In short, then, the growth we are considering makes up a very large part of the current population increase of this country. It is predominantly metropolitan in character. It is forming a new, much more widely dispersed pattern of settlement than was characteristic of earlier urbanization. The process by which this is being done is a complex phenomenon. We know relatively little about it, but quite surely its component parts are concentrating relatively more persons of low income status in central cities, more of middle income in the suburbs, and in the fringe areas, very heterogeneous groupings, whether they be described in economic or cultural terms.

Contributing Factors

Before we can look at the economic implications of current urban growth with any prospects of accomplishment, at least one other question must be considered: Is the current pattern of urbanization likely to continue, with or without material change, or is it a tempo-

rary phenomenon resulting from conditions peculiar to the immediate post-World War II period?

I suggest that this question can be answered today only by listing the factors or forces that we have some reason to believe are contributing to current urbanization (that is, to its volume, character, or both) and then asking two more questions: (i) On balance, do these factors seem likely, in the years just ahead, to become stronger, weaker, or to remain about the same? (ii) Can we foresee new forces that might either counteract existing factors or supplement them, either in their present or future form? Here, again, our knowledge of the factors and, particularly, of their relative strength is insufficient for a definitive analysis. And again, space limitations require a truncated discussion of the questions. In brief outline, however, I suggest we can identify at least several factors and groups of factors in current urbanization.

High agricultural production and its necessary concomitant, efficient means of transporting food and fiber to urban centers and distributing them there, are so elementary that they need no comment. In all probability both will increase in the future. A high level of general economic activity, particularly in urban-located manufacturing, distribution, and service trades, is a generally recognized condition of urban growth. Its immediate future is not too clear—at least not to me. Over the longer run, perhaps we are justified in assuming that, by and large, it will be maintained.

Other factors are certain technological developments including widespread ownership and use of the automobile, availability of electric power in nearly all parts of metropolitan areas, the lowly septic tank, the telephone, radio and television, and, perhaps, even the power lawn-mower. All of these and other items in our much-advertised, mechanically-oriented civilization have contributed strongly to the dispersed character of recent urban growth. In all probability, there will be no diminution in them or in their effects on urban patterns.

Certain public policies make suburban and fringe area living either possible for or more attractive to many people. In this category fall state and federal grants-in-aid, particularly for schools and highways, and federally encouraged practices in small house financing, particularly the high percentage, long-term, amortized mortgage. Not

many people, I believe, know that roughly one-quarter of the aggregate revenues of local governments in this country are now in the form of grants from state governments. A large proportion of these grants are for schools and highways. Although highway grants usually are limited to certain classes or kinds of roads, they enable local governments to build and maintain substantially more all-weather roads than they otherwise would. Forecasting the probable future of such measures may be risky, but I see no likelihood that these aids will be curtailed. Quite surely some of them will be strengthened. Others may well be added. In these circumstances, their byproduct effects on the new pattern of urban settlement seem likely to continue.

Another factor in current urbanization is that characteristic of many intergroup relations that is becoming known as *exclusionism*. This refers to the misunderstandings, animosities, dislikes, and antipathies among many members of racial, national origin, economic, and other groups that make them uneasy neighbors and lead to various degrees and kinds of residential segregation. I would like to believe, of course, that as our urban culture grows more mature these divisive and essentially undemocratic factors will decline. Maybe they will, maybe not. These factors, however, seem to me somewhat different from most of the others we can identify. Although they clearly are influencing the *character* of current urban dispersal, I doubt that they are very significant in the degree or extent of it.

In nearly all of the few studies of people's reasons, or what they think or say are their reasons, for preferring suburban and fringe area living, space turns up very frequently and prominently. The ways it is expressed to the interviewers vary widely, but it cannot be mistaken. Many people, quite possibly an increasing number of them, want and seem determined to get space or spaciousness for themselves and their families. It means less congestion and tension, more play space and safety for the children, more privacy, escape from the clamor, dirt, and confusion of high density districts, more greenery and beauty in their surroundings, chance for a wider variety of hobbies and avocations, and usually easier access to the open countryside. Too much of the discussion of this aspect of current urbanization has been shrill and subjective. Some commentators who do

not share this value spend considerable time belittling it and deriding those who recognize it and are trying to understand it. There is no evidence, however, that any appreciable number of urbanites pay serious attention to these outcries.

Some students of the urban scene think they see evidence of a backflow from the less densely to the more densely built parts of metropolitan areas. This may well be taking place. With some 10 million persons—many of them adults—coming into suburban and fringe areas in six years, some reshifting certainly is to be expected. No evidence I have seen so far indicates this backflow is more than minor. I look for this factor of space or spaciousness as a value to continue strong in the changing urban scene.

Although the connection between leisure time and dispersed metropolitan development is quite obvious, in my opinion this is the most generally underestimated of all the major factors influencing urbanization. More leisure time for more people means more opportunity and more energy for the activities and ways of living common to suburban and fringe areas. To some degree, it probably lessens the drag of long journeys to and from work. It seems likely to be an even more powerful force in the future than it is today, regardless of how the probable increase in leisure time affects the length of the work day, week, year, or lifetime.

In the various combinations or mixes in which these influences operate, they amount to formidable forces in our economy and society. Also, although from time to time and place to place some of these combinations of forces may lessen temporarily, over the next generation or so they seem likely to increase, rather than to decline, in their effect on metropolitan growth patterns.

In broad terms, I see also two main dangers or threats to urban growth and change in something like the forms they have taken in recent years. The first of these would be a substantial and long-sustained lowering in the level of general economic activity. Although this is by no means inevitable, it seems quite possible. The other is the performance of construction costs, particularly of house-building costs, in the post-World War II period. The best information available shows that from 1946 to 1955 the median dollar income of urban and rural nonfarm families increased by 58 percent (4). For the same period, the Bureau of Labor Statistics estimated that the average construc-

tion cost of privately owned, nonfarm dwelling units started went up by 96 percent. For single-family houses the increase was 105 percent (5). Also, for August 1957, the Boeckh index of residential construction costs was at an all-time high, despite the fact that the seasonally adjusted monthly index of nonfarm dwelling unit starts (privately owned) had been moving generally downward for more than two years and in that month was more than 25 percent below the level of January 1955 (6). Clearly, this, if continued, can become a threat to vigorous metropolitan growth in the current patterns. Over the past few years its effects have been largely offset by easier financing terms, so-called (that is, smaller down payments and longer term mortgages), particularly on FHA insured and GI loans. But we are about at the end of that road, unless, of course, interest rates on small house mortgages decrease substantially.

Some Implications

From our admittedly poor knowledge of current metropolitan growth and our even poorer understanding of what lies behind it, no one can see, clearly and unmistakably, all or nearly all of its economic implications. Let me, however, list what seem to me the principal ones.

Future urban growth will call for many types of capital investment, both private and public—all on a large scale, some of them on an unprecedented scale. Thus, it could be a major stimulant to the economy and, in some circumstances, a contributor to inflation. Because of the low birth rates during the 1930's, the current rate of household formation in this country, a crucial factor in over-all housing need, has fallen off somewhat. In the early 1960's, however, it probably will pick up rapidly and may well surpass materially past rates, except those of the first few years after World War II (7). To some degree, postwar urban growth has been using up excess capacity in public facilities of various kinds. By and large, however, this process is now over. Evidence of this is in the rise of public investment in such facilities over the past few years. Outstanding local government debt in the United States went up by more than 92 percent from 1950 to 1956 (8). From now on, investment for these purposes may be expected to move up more sharply or shortages in some of the essential facilities of urban living—

schools, hospitals, highways, water, and sewer works—will become very serious.

Unless fairly drastic remedies are applied soon, the financial plight of many local governments in metropolitan areas will be aggravated to the point of crisis. The basic troubles here seem to be three: (i) the regressive, inflexible character of the principal sources of local tax revenue; (ii) antiquated, unrealistic debt limitations; and (iii) the Balkanization of local government jurisdictions that results in many local areas that are uneconomic for the provision of at least some services and also often results in great disparities in tax paying and borrowing capacity from local jurisdiction to local jurisdiction. To these are now added substantially higher costs of money to local governments. The yield on municipal bonds in late 1957 ranged from almost 4 percent to about 3.50 percent. For comparison, the average yield in 1950, on the same index (Standard and Poor's), was slightly under 2 percent (9).

The headlong growth and dispersal of metropolitan populations is bringing more and more into the spotlight of thoughtful discussion the concept of the physical plant of metropolitan areas. By *plant* in this context is meant the size, location, and relation to each other of the major land-use districts, the densities of their development, the transit and transport facilities by means of which people and goods are moved around and among them, and the utility facilities that serve them with power, light, communication, and water. An analogy, of course, is to a manufacturing plant—the amount and layout of floor space; its arrangement—whether on one or two floors or on several; the location and relation to each other of various departments in which raw materials or component parts are shaped, treated, and assembled; and the transport system by which materials and products move into, out of, and within the buildings and grounds of the establishment. But whereas many, perhaps most, industrial plant managers know about what size and kind of plant will approach the optimum for turning out the products of their companies, who knows what sizes and patterns of metropolitan plant will make possible the most efficient provision of public services and contribute most to the effective prosecution of the chief human activities—of individuals, families, and of business and industrial enterprises—that are carried on within it?

The pressures of urban growth in the

near future may well sharpen this question to the point at which it can no longer be ignored. Once it is faced, responsible officials and other citizens may see, much more clearly than many of them now do, a substantial part of the case for metropolitan planning—financed and prosecuted at a substantially higher level than obtains in any metropolitan area today. And it should be only a short step further for these persons to realize that metropolitan planning can be truly effective only if the planning process is an integral part of a local government with metropolitan-area wide jurisdiction for certain purposes and services.

Lest I be misunderstood on this point, let me add three short comments. I do not believe that a metropolitan plant conducive to efficiency in public services and private activities is the only or even the highest objective of metropolitan planning and development. It is, however, an important one. Neither do I suggest that planning and guidance of metropolitan growth can or should be as close or as detailed as planning for an industrial plant. No one pattern of growth will be found best for all metropolitan areas, and, for any one, our present techniques and knowledge will often indicate more than one acceptable possibility. Finally, I believe that two of the most troublesome problems of metropolitan development—the money and the real costs of the journey to work and the plight of transit and transport services—are properly seen not as discrete or separable questions but as integral and important parts of this more inclusive issue.

Future urban growth seems almost certain to aggravate the already formidable problems of central business districts in central cities. It also may well hasten the onset of similar difficulties in the older and larger suburbs.

The current ills of central business districts are largely attributable to three conditions. Blight, largely in the form of obsolete, overly dense residential development in near-in parts of central cities, has hastened the outward movement of many well-to-do and middle income families on whose aggregate purchasing power stores, shops, and some other central business district operations have depended heavily. Much of this purchasing power is now being spent in other districts, including, but not limited to, the major outlying shopping centers, which have sprung up so rapidly in recent years, and which are more conveniently located for many of these cus-

tomers. Secondly, most central districts, particularly those in the larger cities, have sought and encouraged a fairly high degree of congestion. Over the years transit facilities and major street systems have poured more and more customers and workers into these areas. Property values reflect this concentration of business activities. Employees and customers endured the resultant crowding and inconvenience as long as they had, or felt that they had, no feasible alternative. Both, but particularly the retail customers, now feel otherwise and are acting accordingly. But attempts to redress the competitive position of central business districts in respect to many businesses are severely hampered by the huge investment in and high asking prices for central district properties. Finally, transit and traffic congestion for many people going to and from the central business districts has been worsened by a smaller but still considerable volume of bus, subway, and car riders whose destinations are in the areas immediately around the business district. Some of these latter travelers are engaged in businesses, industries, and services that can operate most efficiently only in such locations—that is, near at hand to the central district. Quite as clearly, however, some undetermined but substantial proportion of them are adding to the congestion in the central areas largely because only in their peripheries, more specifically in the old, largely obsolete buildings typical of such locations, can their employers find the combination of a sizable, easily tapped labor pool and cheap rents.

Even such a quick and incomplete analysis suggests the seriousness of the present plight of many central business districts. In my opinion, the nature of the current and prospective urban growth as well as their rate or speed indicate that this plight will become worse before it becomes less severe. It is one of the most difficult problems among the by-products of recent and prospective urban growth. My task here is to point up implications of growth, not to propose or to discuss remedies for all urban ills. Maybe, however, I should say that I do not share the view that central business districts in metropolitan areas are doomed to wither and fade away. Neither do I subscribe to the firm assertions, for which no evidence seems to be forthcoming, that unless these districts are maintained, at whatever costs to public and private purses, at their present size, pattern, and character, dire consequences for the economic and social

health of their metropolitan areas are certain to ensue. Rather, I would expect that, over the next generation or more of urban development, many central districts will become more specialized functionally and will change substantially in their physical character and density. The principal questions of public policy, then, are how these changes are to be brought about more rapidly and orderly and in ways that will maximize the benefits, direct and indirect, over the costs, also direct and indirect.

Finally, I think we can expect that with continuing urbanization the blighting process in the older parts of metropolitan areas, particularly in the central cities, will continue and may even accelerate in the near future. It may well show up in the older suburbs on a considerable scale. In my opinion it is at least a potential threat in many outlying areas built up since World War II. Unfortunately, many of them have at least some of the seeds of deterioration and blight: construction of not too high quality; inadequate open space and space for public activities, institutions, and services; a high proportion of small units that make for overcrowding and high rates of turnover; a shortage, to put it mildly, of those amenities important in residential quality and character that make for stability of occupancy and pride in one's house and its neighborhood.

Although, under the label of urban redevelopment or renewal, many municipalities are experimenting with attacks on blight in many of its various forms, I doubt that any sizable community has actually reduced its blighted area or materially slowed down the blighting process within its boundaries. This should not astonish anyone who will consider for a moment the obstacles confronting these new, complex, and difficult programs.

Beyond the usual obstacles—financial, administrative, physical and social—to redevelopment programs, I think I see two very disquieting omens for the future of urban renewal and blight prevention. One is the almost total absence of any clear recognition by most central city planners and redevelopment officials of the implications for their programs of this new pattern of settlement that is characteristic of current urbanization. To be sure, not every present and prospective resident of central cities wants open, spacious low-density living areas. Quite as surely, however, many, probably most of them, do not want the kind of quarters and ways of life that go with the so-called high-rise apartment

structures that are becoming the hallmark of redevelopment, even in many cities in which very few, if any, building of this kind had been built until recent years. How big is this market? What should be done with the other blocks or square miles of badly blighted area that cannot be absorbed by such structures? I find disturbingly little serious discussion of such questions, and most of it seems to reflect either ignorance of what is happening to urban patterns in this country and why, or else the curious notion that central city rebuilding can safely proceed without regard to these changing patterns.

The other disquieting aspect of current urbanization is the failure to acquire in advance substantial areas for parks, playgrounds, forest preserves, beaches, schools, libraries, parking lots, and other public and quasi-public uses in the rapidly growing suburban and fringe areas. To be sure, many of these areas now seem spacious and open enough, but most of them will fill in fast. As they do, land prices will rise—often sharply. Almost before the need is appreciated, the opportunity to do this crucial job adequately and imaginatively may be gone. And this is just another way of saying that we will have produced x thousands of square miles of urban residential development that almost from its beginning, certainly from its early maturity, will fail to meet the needs of most of its residents. Once such a statement can fairly be made about residential districts, the handwriting of eventual blight is on the wall for nearly all of them.

As one looks back over my observations on the probable and possible consequences of urban growth in the near future, he might conclude that, with few exceptions, the implications are gloomy indeed. Growth, so it seems, is going to produce some new problems and aggravate many others, possibly to a degree that will make them almost new difficulties for a healthy urban economy. Of course I would defend my conclusions as realism; to others they may seem the fears of a tired and weak mind. Be that as it may, it seems likely (although not much direct evidence is at hand) that scores of thousands of families whose decisions and actions, in the aggregate, have made the current pattern of urban development over the past few years have added to the sum total of their satisfactions and utilities. If economics is concerned with the allocation of scarce resources to meet human needs, this accomplishment is a

notable economic implication in its own right. Unless, however, the problems I have tried to sketch are dealt with intelligently, the degree of utility found in living in these newer areas may well decline; the costs, real and monetary, will surely rise, both for residents of these districts and for those in other parts of metropolitan areas, often miles away, who will have to pay, in one way or another, for some of the by-products of urban growth.

The Time Element

At several points in this paper I have adverted to the time element or the actual and the probable future rate of urban growth. Now I wish to emphasize briefly this aspect of the matter because it is a significant factor, both in a true picture of urban increase and in the problems of public policy that urban growth and its economic implications raise. Only a very few indicators of this element can be cited.

According to the latest projections of the Bureau of the Census, the population of the United States in 1975 may be between 216 million and 244 million people (10). For our purposes we may take 220 million as a round and not improbable figure. This would mean an increase of roughly 70 million over 1950. If metropolitan areas should continue to get 85 percent of the national population growth (the proportion they are thought to have received over the first 6 years of this 25-year period), their increase would be about 59.5 million. (On the same basis of estimate, the nonmetropolitan urban areas would increase by slightly less than 7 million.)

An increase of 59.5 million in metropolitan populations in 25 years may seem offhand a substantial volume of growth. Two comparisons may give it more meaning. In 1950 the officially designated metropolitan areas had an aggregate population of 83.8 million. Thus, the increase projected for 25 years is approximately 71 percent of the total metropolitan population at the beginning of the period. Also, of the 168 Standard Metropolitan Areas in 1950, 14 had populations of more than 1 million. Their aggregate population was 44.4 million. The projected metropolitan population growth for 25 years, therefore, is roughly equal to the 1950 populations of the metropolitan areas (not of their central cities alone) of New York-Northeastern New Jersey, Chicago, Los Angeles,

Philadelphia, Detroit, Boston, San Francisco-Oakland, Pittsburgh, St. Louis, Cleveland, Washington, Baltimore, Minneapolis-St. Paul, and Buffalo, plus 15 million persons more.

For me, these are sobering if not staggering figures. When against this backdrop one reviews the problem, implications that I have tried to outline as well as others, both economic and non-economic in character, that might be added, and considers how ill prepared we in this predominantly urban nation are to deal with them intelligently and in time, he may be pardoned if he concludes that this country has a few things to worry about besides the Sputniks. The metropolitan outlook is grave, in my opinion, not because its problems are impregnable, but because our poor preparation for dealing with them is found on so many fronts—in basic understanding of the problems themselves, in governmental and private institutional means for deciding on policies and pressing forward with them, and in public appreciation of the scale and seriousness of the issues.

In the lifetimes of most of us, not only the face but also the physique of urban America is going to be changed—radically changed. In my opinion we simply cannot afford to muddle along as we are now doing—building a parking garage here or there, transferring a bankrupt transit company to public ownership, tearing down a few blocks of old houses, hiring another junior planner or two when we can find them, nursing our petty, parochial prejudices, whether in central city or suburb, trying to decide if we should not raise the dog license fee a dollar to keep our local government out of the clutches of that evil foreign octopus that is headquartered in Washington, and tentatively suggesting that maybe it is about time to begin to think about setting up a metropolitan planning body or a special authority responsible for both water supply and sewage disposal. If we continue in this vein, well before 1975 we will have lost one of the finest opportunities any generation of Americans ever had: the opportunity to make our rapidly growing urban localities into things of

economy, beauty, and livability, appropriate settings for metropolitan communities that we and our children can live in and take part in with pride.

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Biochemical Theories of Schizophrenia

Part II of a two-part critical review of current theories and of the evidence used to support them.

Seymour S. Kety

In part I of this article [*Science*, 129, 1528 (1959)], an attempt was made to discuss the possible sources of error peculiar to biological research in schizophrenia, including the possible heterogeneity of that symptom complex and the presence of certain biological features—such as adventitious disease, nutritional deficiencies, disturbances associated with abnormal motor or emotional states, and changes brought about by treatment, all of which may be said to result from the disease or from its current management

rather than to be factors in its genesis. The difficulty of avoiding subjective bias was emphasized. Some of the hypotheses relating to oxygen, carbohydrate, and energy metabolism, to amino acid metabolism, and to epinephrine were presented, and the existing evidence relevant to them was discussed. Among the recent or current concepts there remain to be discussed those concerned with ceruloplasmin, with serotonin, and with the general genetic aspects of schizophrenic disorders.

Ceruloplasmin and Taraxacin

The rise and fall of interest in ceruloplasmin as a biochemical factor significantly related to schizophrenia is one of the briefest, if not one of the most enlightening, chapters in the history of biological psychiatry. The upsurge of interest can be ascribed to a report that a young Swedish biochemist had discovered a new test for schizophrenia. The test depended upon the oxidation of *N,N*-dimethyl-*p*-phenylenediamine by ceruloplasmin (1, 2). It is difficult to understand the exaggerated interest which this report aroused, since Holmberg and Laurell (3) had demonstrated previously that ceruloplasmin was capable of oxidizing a number of substances, including phenylenediamine and epinephrine, and Leach and Heath (4) had already published a procedure based on epinephrine oxidation which was equally valid as a means of distinguishing schizophrenics from normal subjects and had identified the oxidizing substance as

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ceruloplasmin (5). All of these observations were compatible with earlier reports in the German literature (6) of an increase in serum copper in schizophrenia and with the demonstration that practically all of the serum copper was in the form of ceruloplasmin and that the levels of this compound in blood were elevated during pregnancy and in a large number of diseases (7, 8). There had even been preliminary observations of an increase in blood ceruloplasmin in schizophrenia (8). Following the announcement of the Akerfeldt test, however, interest in copper and ceruloplasmin rose, and very soon a number of investigators reported this reaction, or some modification of it, to be positive in a high percentage of schizophrenics (2, 9), although as a diagnostic test the Akerfeldt procedure was discredited because of the large number of diseases, besides schizophrenia, in which the results were positive. Both Akerfeldt and Heath recognized that ascorbic acid could inhibit the oxidation of phenylenediamine and of epinephrine, respectively, but neither felt that this was crucial to his findings, since each had satisfied himself that the feeding of large doses of ascorbic acid to the patients had not influenced the respective reactions (2). In addition, Abood (9), who used a modification of the Akerfeldt procedure which was not affected by ascorbic acid, was able to obtain a positive reaction indicating abnormally high ceruloplasmin levels in two-thirds of the more than 250 schizophrenics he had examined.

In the past 18 months there has been a remarkable decline in the interest in, and the reported levels of, ceruloplasmin in schizophrenia. In May of 1957, McDonald (10) reported his findings on three groups of schizophrenics, one group from the wards of the National Institute of Mental Health, where the patients had been maintained on a more than adequate diet, and two groups from state hospitals. He performed the Akerfeldt test and the Abood modification of it, as well as independent tests to measure ascorbic acid and copper, on these groups and on three groups of controls. In none of the schizophrenic groups was there an increase in serum copper or other evidence of increase in ceruloplasmin. In the state-hospital patients and one group of controls, however, ascorbic acid levels were low and the results of Akerfeldt tests were positive, whereas in schizophrenic patients from the National Institute of Mental Health, levels of ascorbic acid were normal and the results

of Akerfeldt tests were negative. It was clear that a high ceruloplasmin level was not characteristic of schizophrenia and that a positive response to the Akerfeldt test, where it occurred, could be completely explained by a dietary insufficiency of ascorbic acid.

In findings of the Tulane group, the mean values for serum copper in schizophrenia have decreased from a high of 216 micrograms per 100 milliliters in 1956 (5) to 145 micrograms per 100 milliliters at the end of 1957 (4), mean normal values having remained at 122 and 124 micrograms per 100 milliliters during the same period. Other groups have found slight differences or no differences at all with respect to blood levels of ceruloplasmin or copper between schizophrenic and normal subjects (11) and no support for the theory that the Akerfeldt test is a means of distinguishing between schizophrenic and non-schizophrenic patients (12). It is not clear why some schizophrenics apparently show an elevated level of ceruloplasmin in the blood; among suggested explanations are dietary factors, hepatic damage, chronic infection, or the possibility that excitement tends to raise the level of ceruloplasmin in the blood, as preliminary experiments appear to indicate (13).

Quite early in their studies, members of the Tulane group recognized that the potent oxidant effects of the serum of schizophrenics on epinephrine in vitro could not be satisfactorily explained by the ceruloplasmin levels alone (5). Before they recognized the importance to this reaction of ascorbic acid deficiency (14), they had postulated the presence in the blood of schizophrenics of a qualitatively different form of ceruloplasmin (5), which they proceeded to isolate and to test in monkey and man, and to which they have given the name *taraxein* (from the Greek root *tarassein*, meaning "to disturb"). They have reported that when certain batches of this material were tested in monkeys, marked behavioral and electroencephalographic changes occurred. When samples of these active batches were injected intravenously at a rapid rate into carefully selected prisoner volunteers, all of the subjects developed symptoms which have been described as characteristic of schizophrenia—disorganization and fragmentation of thought, autism, feelings of depersonalization, paranoid ideas, auditory hallucinations, and catatonic behavior (15-17).

Demonstration of toxic materials in

the blood and in the body fluids of schizophrenic patients is not new. The voluminous and inconclusive work of earlier investigators was well reviewed by Keup in 1954 (6). Since that time, many new reports have appeared, although there has been no extensive substantiation of any of them. The results of one, on the toxicity of serum and urine of schizophrenic patients for the larvae of *Xenopus laevis* (18), were disputed by the laboratory in which the work was done (19). Edison (20) was unable to demonstrate toxicity of such serum for the species of tadpole previously used, or for other species and other genera. A report that serum from schizophrenic patients is toxic to cells in tissue culture (21) lost some of its significance when 1 year later the same laboratory reported that the sera of surgical patients (22) was of comparable toxicity. Reports that injection of certain extracts of the urine of schizophrenic patients induces electroencephalographic and behavioral changes in rats (23) or disturbances in web construction in spiders (24) have not yet received confirmation in the scientific literature. Such urine, however, has been reported to have no effect on the Siamese fighting fish, which is remarkably sensitive to certain hallucinogens (25). Contrary to earlier findings, a recent attempt to demonstrate behavioral changes in rats following the injection of cerebrospinal fluid from catatonic patients was unsuccessful (26). A highly significant decrease in rope-climbing speed in rats injected with sera from psychotic patients as opposed to sera from nonpsychotic controls has been reported by Winter and Flataker (27). Their later finding (28) that the phenomenon occurs with sera of patients with a wide variety of mental disorders, including mental retardation and alcoholism, and that there is a considerable variation in this index between similar groups at different hospitals, coupled with the inability of at least one other investigator (29) to demonstrate this phenomenon in the small group of schizophrenic patients under investigation in this laboratory, suggests that the quite real and statistically significant phenomenon originally observed may be related to variables other than those specific for, or fundamental to, schizophrenia. More recently, Ghent and Freedman (29) have reported their inability to confirm the observations of Winter and Flataker.

It has been reported that rabbits pretreated with serum from schizophrenics

do not exhibit a pressor response following the local application of an epinephrine solution to the cerebral cortex (30). No difference between the action of sera from normal subjects and that from schizophrenics was demonstrated by means of this procedure in tests of sera from a small number of individuals on our wards.

The significance of all of these studies in animals, whether the studies are successful or unsuccessful in demonstrating a toxic factor in schizophrenia, is quite irrelevant to, and considerably dwarfed by, the implications of the taraxein studies. It is because of the tremendous implications which these results could have in the etiology and rational therapy of this important disorder that a reviewer must evaluate them with even more than the usual care.

In the first place, the important biochemical phenomena originally reported in schizophrenia—lowered blood levels of glutathione and rapid oxidation of epinephrine *in vitro*—which prompted the search for taraxein and directed work on its isolation toward the ceruloplasmin fraction of serum (15, 16, 17), have since been controverted by data reported by the same group, as well as by others and have been regarded by most workers as spurious or at least unrelated in any direct way to the schizophrenic process (14, 31). This, in itself, does not preclude the possible validity of the taraxein phenomenon, since bona fide discoveries have occasionally been made on the basis of erroneous leads; it does, however, reduce the probability of its occurrence from that involved in a logical interrelationship of sequential proven steps to the extremely small chance of selecting this particular and heretofore unknown substance from the thousands of substances which occur in blood and which might have been chosen.

One attempt by Robins, Smith, and Lowe (32) to confirm the Tulane findings, in tests in which they used comparable numbers and types of subjects and at least equally rigorous controls, was quite unsuccessful. In 20 subjects who at different times received saline or extracts of blood from normal or schizophrenic donors, prepared according to the method for preparing taraxein, there were only five instances of mental or behavioral disturbance resembling those cited in the original report on taraxein, and these occurred with equal frequency following the administration of saline, extracts of normal plasma, or taraxein. It is easy to dismiss the negative findings

with taraxein on the basis of the difficulty of reproducing exactly the 29 steps described in its preparation; it is considerably more difficult to dismiss the observation that a few subjects who received only saline or normal blood extract developed psychotic manifestations similar to those reported with taraxein.

During the preliminary investigations it was stated, on the basis of unpublished studies (5), that taraxein was qualitatively different from ceruloplasmin. A physicochemical or other objective characterization of taraxein would do much to dispel some of the confusion regarding its nature. Is it possible, for example, that taraxein is, in fact, ceruloplasmin but ceruloplasmin that derives its special properties from the psychosocial characteristics of the situation in which it has been tested? This question was raised more than a year ago (33), and since then additional evidence has become available which tends to support it. This is a detailed report from a psychoanalyst at Tulane of the experience of one of his patients who received taraxein (34). Even though a "double blind" procedure was said to have been used, there are enough possibilities for the operation of unconscious bias in this one case, if it is at all typical of the means used to demonstrate the psychotomimetic properties of taraxein, to raise some doubts concerning the validity of these properties. The subject, a psychiatric resident, knew before the injection that he was to get either saline or a potent sample of taraxein which had made a monkey catatonic for several hours. Immediately following the injection he noted venous distension, tachycardia, a swollen feeling of the head, and flushing of the head and face, which, a footnote explains, was probably a reaction to the ammonium sulfate in the taraxein solution. Following these symptoms, which the subject could hardly have attributed to saline, there ensued a period of introspective cogitation, with occasional mild mental disturbances quite compatible with the anxiety-producing nature of the situation, with the preparation and cues which the subject had received, and with his anticipation of marked psychotic reactions and not necessarily symptomatic of a chemical toxin at all. The changes were not qualitatively dissimilar to those which Robins and his associates had on a few occasions obtained with their control solutions (32). The report of the observer who injected the material was longer and mentioned more numerous and

more bizarre subjective feelings than the subject himself reported. The observer's summary of the subject's reactions as blocking of thought processes, autism, bodily estrangement, and suspiciousness seems incompletely supported by the subject's retrospective report.

The possibility, remote as it may be, that the reported effects of taraxein are the result of a combination of suggestion, nonspecific toxic reactions from ammonium sulfate or other contaminants, and reinforcement of these cues by the unconscious biases of subject and observer through the device of an unstructured interview, is one which has not been ruled out. Hypotheses related to the mechanism of action of this material have moved from concern with abnormalities in the blood to concern with abnormalities in the blood-brain barrier; but the question of whether taraxein acts as a biological cause or as a mediator of some of the symptoms of schizophrenia is by no means resolved. I have already mentioned the only attempt of which I am aware on the part of an independent group to confirm the original results in a controlled series of significant size, and that attempt was unsuccessful.

Serotonin

Serotonin, an important derivative of tryptophan, was first shown to exist in the brain in high concentration by Amin, Crawford, and Gaddum (35). Interest in its possible function in the central nervous system and speculation that it might even be related to schizophrenia were inspired by the finding that certain hallucinogens, notably lysergic acid diethylamide, could, in extremely low concentration, block the effects of serotonin on smooth muscle. Thus, Woolley and Shaw in 1954 (36) wrote: "The demonstrated ability of such agents to antagonize the action of serotonin in smooth muscle and the finding of serotonin in the brain suggest that the mental changes caused by the drugs are the result of a serotonin-deficiency which they induce in the brain. If this be true, then the naturally occurring mental disorders—for example, schizophrenia—which are mimicked by these drugs, may be pictured as being the result of a cerebral serotonin deficiency arising from a metabolic failure. . . ." Simultaneously, in England, Gaddum (37) was speculating, "it is possible that the HT in our brains plays an essential part in keeping

us sane and that the effect of LSD is due to its inhibitory action on the HT in the brain." Since that time additional evidence has appeared to strengthen these hypotheses.

Levels of serotonin have been found to be considerably higher in the limbic system and other areas of the brain which appear to be associated with emotional states (38) than elsewhere. Bufotenin, or dimethyl serotonin, extracted from a hallucinogenic snuff of West Indian tribes, was found to have some properties similar to those of lysergic acid diethylamide (39). A major discovery was the finding that the ataractic agent, reserpine, causes a profound and persistent fall in the level of serotonin in the brain (40), a process which more closely parallels the mental effects of reserpine than does its own concentration in the brain. By administration of the precursor, 5-hydroxytryptophan, the levels of serotonin can be markedly elevated in the brain, with behavioral effects described as resembling those of lysergic acid diethylamide (41)—a finding quite at odds with the original hypotheses. On the other hand, administration of this precursor to mental patients, along with a benzyl analog of serotonin to block the peripheral effects of the amine, has been reported, in preliminary trials, to suppress the disease (42), while confusion is compounded by the report that the benzyl analog alone is an effective tranquilizing drug in chronically psychotic patients (43).

Still another bit of evidence supporting the hypotheses of a central function for serotonin was the accidental discovery of toxic psychoses in a certain fraction of tuberculous patients treated with iproniazid (44, 45), which has led to the therapeutic use of this drug in psychic depression. It is known that iproniazid inhibits the action of monoamine oxidase, an enzyme which destroys serotonin, and it has been shown that iproniazid increases the levels of this amine in the brain (41).

There are certain inconsistencies in the data cited above to support the serotonin hypotheses, and no single theory has been found to explain all of the findings, even though full use is made of the concept of "free" and "bound" forms and of the common pharmacological principle of stimulant and depressant effects from the same drug under different circumstances. Moreover, certain weaknesses have appeared in each of the main supporting hypotheses, and these should be noted.

Although the ability of the hallucinogenic lysergic acid diethylamide to block effects of serotonin on smooth muscle prompted the development of the hypotheses relating serotonin to mental function or disease, a number of lysergic acid derivatives have since been studied, and the correlation between mental effects and antiserotonin activity in the series as a whole is quite poor (46). One of these compounds is 2-bromo-lysergic acid diethylamide; this has 1.5 times the antiserotonin activity of lysergic acid diethylamide, and through this property, its presence in the brain, after systemic administration, can be demonstrated, but in doses more than 15 times as great it produces none of the mental effects of lysergic acid diethylamide (46). A recent report that, at least in one preparation, lysergic acid diethylamide in low concentration behaves like serotonin and does not antagonize it (47) seems to reconcile some of the empirical inconsistencies in the field, although it is quite at odds with the original hypotheses based on the antagonistic action of lysergic acid diethylamide.

Levels of norepinephrine as well as serotonin are markedly lowered in the brain following administration of reserpine (48). In fact, the brain concentrations of these two amines follow each other so closely in their response to reserpine as to suggest some mechanism common to both and perhaps obtaining as well for other active amines in the brain. In one study, 3,4-dihydroxyphenylalanine, a precursor of norepinephrine, was capable of counteracting the behavioral effects of reserpine, whereas the precursor of serotonin was ineffective (49). Moreover, the effects of iproniazid are not limited to brain serotonin; a comparable effect on norepinephrine has been reported (50), and it is possible that other amines or substances still to be discovered in the brain may be affected by what may be a nonspecific inhibitor of a relatively nonspecific enzyme. Of great interest in this connection are recent studies of Olds and Olds (51) indicating a positive behavioral response for iproniazid injected into the hypothalamus but not for serotonin or norepinephrine.

Chlorpromazine, which has the same therapeutic efficacy as reserpine in disturbed behavior, is apparently able to achieve this action without any known effect on serotonin. In addition, the provocative observation that iproniazid, which elevates serotonin levels in the brain, can cause a toxic psychosis loses some of its impact when one realizes

that isoniazid, which does not inhibit monoamine oxidase and can hardly raise the brain serotonin concentration, produces a similar psychosis (45, 52).

It seems reasonable to conclude that the serotonin as well as the norepinephrine in the brain have some important functions there, and the evidence in general supports this thesis, even though it also suggests that their roles still remain to be defined.

If the picture of the role which serotonin plays in central nervous function is blurred, the direct evidence to support the early speculations that it is involved in mental illness is meager and contradictory. From all of the evidence cited above, one could find a basis for predicting that in schizophrenia the serotonin levels in the brain, if they are altered at all, should be quite low or quite high. Results confirming both predictions have been reported.

The urinary excretion of 5-hydroxyindoleacetic acid has been used as an indicator of the portion of ingested tryptophan which is metabolized through serotonin to form that end product. Although excretion of 5-hydroxyindoleacetic acid is normal in schizophrenic patients under ordinary circumstances (53), it may be altered by challenging the metabolic systems with large doses of tryptophan. Zeller and his associates have reported a failure on the part of schizophrenics, under these circumstances, to increase their output of 5-hydroxyindoleacetic acid, while nonpsychotic controls double theirs (54). Banerjee and Agarwal, on the other hand, have reported exactly the opposite results; in their study it was the schizophrenics who doubled their output of the serotonin end product, while the output of the controls remained unchanged (55).

Kopin, of our laboratory, has had the opportunity to perform a similar study on schizophrenics and normal controls maintained on a good and reasonably controlled diet and given no drugs. In each group there was a slightly greater than twofold increase in output of 5-hydroxyindoleacetic acid following a tryptophan load, and there was no significant deviation from this pattern in any single case (56).

That the heuristic speculations of Woolley and Shaw, and of Gaddum, have not yet been established does not mean that they are invalid. The widespread experimental activity which they stimulated has broadened and deepened our knowledge of the metabolism and pharmacology of serotonin and of its ef-

fects on behavior and may lead the way to definitive evaluation of its possible role in normal and pathological states.

Genetics and Schizophrenic Disorders

Many of the current hypotheses concerning the schizophrenia complex are original and attractive even though, up to this time, evidence directly implicating any one of them in the disease itself is hardly compelling. There is, nevertheless, cogent evidence that is responsible to a large extent for the present reawakening of the long dormant biochemical thinking in this area and sufficiently convincing to promote its continued development. Genetic studies have recently assumed such a role, and it appears worth while briefly to review them in the present context.

In earlier studies on large populations, a remarkable correlation was reported between the incidence of schizophrenia and the degree of consanguinity in relatives of known schizophrenics (57). These findings were not conclusive, however, since the influence of socioenvironmental factors was not controlled. Better evidence is obtained from the examination of the co-twins and siblings of schizophrenics; a number of such studies have been completed and are summarized in Table 1 (57-59). The concordance rate for schizophrenia is extremely high for monozygotic twins in all the studies, while that for dizygotic twins is low and not significantly different from that in siblings, to which, of course, dizygotic twins are quite comparable genetically. Even these studies, however, are not completely free from possible sources of error, and this makes it difficult to arrive at a definitive conclusion regarding the role of genetic factors in this disease. One cannot assume that environmental similarities and mutual interactions in identical twins, who are always of the same sex and whose striking physical congruence is often accentuated by parental attitudes, play an insignificant role in the high concordance rate of schizophrenia in this group. This factor could be controlled by a study of twins separated at birth (of such twins no statistically valid series has yet been compiled) or by a comparison of the concordance rates in monozygotic twins and in dizygotic twins whose zygosity had been mistakenly evaluated by the twins themselves and by their parents and associates. Another possible means of better controlling the environmental variables would be to make a

careful study of schizophrenia in adopted children, with comparison of the incidence in blood relatives and in foster relatives. Perhaps only a survey on a national scale would provide the requisite numbers of cases for any of these studies.

A less satisfactory resolution of this problem can be obtained by an appraisal of environmental similarities in normal fraternal and identical twins. Such a study, on over 100 specific aspects of the environment, has been made (60), and I have assembled the results into a rough index of environmental similarity (Table 2). Although a difference is apparent, in the crude measurement of environmental congruence, between identical and fraternal twins of like sex, it is not statistically significant and can account for only a small fraction of the large difference in concordance with respect to schizophrenia between these types of twins. On the other hand, there is a highly significant difference in environmental similarity between fraternal twins of like and unlike sex which is sufficient to account for the difference in concordance with respect to schizophrenic psychosis between them, for which, of course, there is no tenable genetic explanation.

Two recent reports have been used, but by no means conclusively, in support of the position that too much significance has been attached to environmental factors as determining causes in this disease group. Chapman (61), reporting a case of concordant early infantile autism in identical twins, points out that this disorder has never been reported as concordant in fraternal twins, whereas it has been described in three sets of identical twins. Since fraternal twins occur nearly three times as frequently as identical twins, the evidence cited is suggestive, in spite of the small numbers involved; furthermore, the disease may develop before the personal identifications and interactions peculiar to monozygotic twins have had much chance to operate. Another interesting finding in over 150 families with a single schizophrenic member is that no ordinal position in the family appears to carry specific vulnerability to schizophrenia (62)—a finding completely compatible with genetic theory but more difficult to reconcile with theories of environmental etiology if the assumption is correct that different positions within the family are subject to varying degrees of stress. Of course one may argue quite properly that schizophrenogenic stress exists and can be evaluated only in

terms of the reaction between each individual and his own environment, so that any position on a social, economic, occupational, or birth-order scale may be associated with greatly different degrees of stress for different individuals.

Another possible source of error in the twin studies which have been reported is the personal bias of the investigators who made the judgment of zygosity and the diagnosis of schizophrenia in the co-twins. Until a more definitive study is carried out in which these judgments are made independently, a rough evaluation is possible, at least for the diagnosis of schizophrenia, if not for zygosity, on the basis of diagnoses arrived at in the various hospitals to which the co-twins may have been admitted before or irrespective of their involvement in the study—diagnoses which are not likely to have been contaminated by knowledge about their zygosity. Kallmann has been kind enough to review the material collected in his 1946-49 survey from that point of view. Of 174 monozygotic co-twins of schizophrenic index cases, 103, or 59 percent, had been diagnosed schizophrenic by Kallmann, while 87, or 50 percent, had received a psychiatric hospital diagnosis of schizophrenia prior to any examination made by him. On the other hand, he had made the diagnosis of schizophrenia in 47, or 9.1 percent, of 517 dizygotic co-twins as compared to a hospital diagnosis in 31, or 6 percent. Although the concordance rates based only on hospital diagnoses are lower in both types of twins, for obvious reasons, the striking difference between the two concordance rates remains. Slater (59) has published individual protocols of his cases from which I have made judgments of zygosity and schizophrenia. Of 21 pairs of twins who could be considered definitely uniovular, 15, or 75 percent, were concordant with respect to the simple criterion of admission to a mental hospital, whereas in only 12, or 10.3 percent, of 116 binovular or questionably binovular pairs was there a history of the co-twin's having been admitted to a mental hospital for any psychosis. On the basis of this analysis of the two most recent series, it seems that only a small component of the great difference in concordance rates reported for schizophrenia between uniovular and binovular twins can be attributed to the operation of personal bias in the diagnosis of the disease in the co-twin.

Even the most uncritical acceptance of all the genetic data, however, cannot

lead to the conclusion that the schizophrenic illnesses are the result of genetic factors alone. In 14 to 30 percent of the cases in which schizophrenia occurs in one of a pair of monozygotic twins, the genetically identical partner is found to be free of the disorder (Table 1). Attention has already been called (Table 2) to the higher concordance with respect to schizophrenia and the greater environmental similarities in like-sexed fraternal twins or siblings than in those of unlike sex, and from the same source (57) a difference in concordance is reported between monozygotic twins separated some years before the study (77.6 percent) as opposed to those not separated (91.5 percent). Neither of these observations is compatible with a purely genetic etiology of the disease, and both suggest the operation of environmental factors. Rosenthal (63) and Jackson (64) have pointed out the striking preponderance of female over male pairs concordant for schizophrenia in all of the reported series, whether they be monozygotic or dizygotic twins, siblings, or parent-child pairs. If sampling errors resulting from the greater mobility of males are excluded and the observations are taken as a reflection of the true incidence of this phenomenon, several explanations for it on the basis of social interaction can be given, but none based on purely genetic grounds, unless sex linkage is invoked, for which there is no other evidence.

Clausen has critically reviewed the extensive literature supporting the importance of environmental factors in the etiology of schizophrenic disorders (65). The evidence there seems quite as suggestive as the genetic evidence but by no means more conclusive, since few studies in either field have been completely objective or adequately controlled.

It is both interesting and important to note that even if the conclusions of both the genetic and the environmental approaches to the etiology of schizophrenic psychoses are accepted uncritically, they are not mutually exclusive. Both are compatible with the hypothesis that this group of diseases results from the operation of socioenvironmental factors on some hereditary predisposition, or from an interaction of the two, each being necessary but neither alone sufficient. An excellent example of such a relationship is seen in tuberculosis, where the importance of the environmental microbial factor is undisputed and where, as Lurie (66) has shown, genetic susceptibility is likewise impor-

Table 1. Concordance rates for schizophrenia found in studies of twins.

Investigator	Number of pairs		Concordance rate* (%)	
	Dizygotic	Monozygotic	Dizygotic	Monozygotic
Luxemburger (1928)	48	17	2	59 (67)
Rosanoff <i>et al.</i> (1934)	101	41	10	61
Kallmann (1946)	517	174	10 (15)	69 (86)
Slater (1953)	115	41	11 (14)	68 (76)

* Figures in parentheses indicate rate after correction for the chance that a co-twin, normal at the time of observation, may develop the disease later.

tant; a population sufficiently heterogeneous with respect to susceptibility and exposure to tuberculosis yields results in contingency and twin studies (67) which, before the discovery of the tubercle bacillus, could easily have been used to prove a primary genetic cause—almost as convincingly as the results of similar studies have been used to prove such a cause in schizophrenia. Interestingly enough, studies of tuberculosis made from the socioenvironmental point of view would obviously provide data offering equally convincing proof that exogenous, social, and economic factors play a part. One hypothesis with respect to the schizophrenic psychoses which remains compatible with all the evidence from the genetic as well as the psychosocial disciplines is that these disorders, like tuberculosis, require the operation of environmental factors upon a genetically determined predisposition.

Résumé

Although the evidence for genetic and therefore biological factors as important and necessary components in the etiology of many or all of the schizophrenias is quite compelling, the sign-posts pointing the way to their discovery are at present quite blurred and, to me at least, illegible.

Genetic factors may operate through

some ubiquitous enzyme system to effect general changes in one or another metabolic pathway—changes detectable through studies of blood or urine—and it is to be hoped that the currently active search in these areas will continue.

It is at least equally possible, however, that these genetic factors may operate only through enzymes or metabolic processes peculiar to or confined within the brain, or even within extremely localized areas of the brain. We are in need of new hypotheses such as those of Elkes (68) and many already discussed. In this connection, gamma-amino-butyric acid appears to be just as interesting a substance about which to construct working hypotheses as are the catechols or the indoles. It has been isolated only from nervous tissue, and its metabolism in such tissue has been investigated in some detail (69), while its neurophysiological properties appear to be better defined than are those of the other two groups (70); in addition, its inhibitory properties may have special relevance to diseases where a failure in central inhibition seems to be involved.

Amphetamine possesses remarkable psychotomimetic properties which should not be overlooked. Its ability to produce a clinical syndrome often indistinguishable from schizophrenia (71) and the possible relation of amphetamine to the naturally occurring catechol amines make it at least as inter-

Table 2. Environmental factors in studies of schizophrenia in twins.

Sex	Environmental similarity in normal twins* (%)	Number of pairs	Concordance with respect to schizophrenia† (%)	Number of pairs
<i>Identical twins</i>				
Same	61	70	86	174
<i>Fraternal twins</i>				
Same	53	69	18	296
Different	26	55	10	221
<i>Siblings</i>				
Same			16	
Different			12	

* Estimated from data of P. T. Wilson (1934).

† From data of F. J. Kallmann (1946).

esting as lysergic acid diethylamide.

In addition to techniques at present available in neurochemistry, neurophysiology, and behavioral pharmacology, the development of new methods designed to yield information on processes occurring within the psychotic brain will be needed before our explorations in this field have been exhausted.

But the biochemist must not lose sight of the possibility, which is certainly as great as any of the others, that the genetic factors in schizophrenia operate to determine inappropriate interconnections or interaction between chemically normal components of the brain; if that should prove to be the case, the physiological psychologist, the neurophysiologist, or the anatomist is likely to find meaningful information long before the biochemist does. It would take many biochemists a long time to find a noisy circuit in a radio receiver if they restricted themselves to chemical techniques.

These possibilities are mentioned only to indicate how large is the haystack in which we are searching for the needle; one cannot avoid a feeling of humility when one realizes how slight the chance is that any one of us has already found it, or will find it in a relatively short time.

That is no cause for discouragement, however. It is not necessary that one be convinced of the truth of a particular hypothesis to justify devoting one's energies to testing it. It is enough that one regard it as worth testing, and that the tools be adequate. Modern biochemistry, with its wealth of new knowledge of intermediary metabolism and its array of new techniques for the separation and identification of compounds and the tracing of their metabolic pathways, has provided the biologist interested in mental illness with an armamentarium which his predecessor of only a generation ago could hardly have envisioned. If he chooses from among the approaches which may lead to a definition of the biological factors in schizophrenia those which will in any case lead to a better understanding of the nervous system and of thought processes and behavior, the present surge of enthusiasm will not have been misdirected.

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News of Science

Health for Peace Act Passes Senate

The "Health for Peace Act," Senate Joint Resolution 41, introduced in the Senate by Senator Lister Hill (D-Ala.) in February, was passed on 20 May by a vote of 63 to 17. The bill, which had 63 sponsors, provides for the establishment of a National Institute for International Medical Research within the National Institutes of Health and of an accompanying 18-member National Advisory Council. The members of the council will be leaders in medical and health research and public affairs generally. With the Surgeon General as chairman, and with a few additional government representatives to assure interagency coordination, the council will help guide policy, make recommendations, pass on grants and loans, and report periodically to the Secretary of Health, Education, and Welfare, to the President, and to Congress. The bill also authorizes the appropriation for the program of \$50 million annually to be spent under the supervision of the Secretary of Health, Education, and Welfare, chiefly through the U.S. Public Health Service.

Activities Authorized

Some of the purposes of Senate Joint Resolution 41 are as follows.

- 1) To encourage and support the planning of essential research into disease, disease prevention, and the impairments of man, on a worldwide basis.
- 2) To encourage and support, in part through direct financial grants and loans of equipment, specific research projects on diseases and physical disability that are being conducted in institutions abroad.
- 3) To encourage and support the coordination of medical experiments and programs of research in the United States with complementary programs abroad.
- 4) To encourage and support the training of specialized research personnel through various means, including the establishment of research fellowships within the National Institutes of Health and elsewhere, both in the United States and abroad.
- 5) To encourage the improvement of research facilities abroad.

6) To encourage and support the rapid international interchange of knowledge about disease and disability, including the holding of international conferences and arrangements for translation and distribution services.

7) To cooperate with the research activities of the World Health Organization, the Pan-American Health Organization, the United Nations Children's Fund, and other international organizations.

Although the principal governmental machinery proposed would be in the National Institutes of Health, there is provision, too, for the use of the Office of Vocational Rehabilitation and of the Children's Bureau in carrying out pertinent portions of the program.

Purposes Defined

When he introduced the bill, Senator Hill emphasized that its aim was humanitarian and that there were no political implications except that it would serve as a major instrument for world peace. He referred to an amendment to the Mutual Security Act that was passed last year which stated that it is the "policy of the United States to continue and to strengthen mutual efforts among the nations for research against diseases such as heart disease and cancer. In furtherance of this policy, the Congress invites the World Health Organization to initiate studies looking toward the strengthening of research and related programs against those and other diseases common to mankind or unique to individual regions of the globe." Hill pointed out that the purpose of his bill was to implement this policy by authorizing the establishment of governmental machinery for the "effective mobilization of our own research facilities and resources and authorizing also a series of programs which will translate the declaration of a policy and a purpose into concrete action." Hill also observed that if the Congress passes his measure, "notice will be served to all nations and all peoples that the U.S. Government desires that a new and substantial emphasis be given to world cooperation. . . ."

Representative John E. Fogarty (D-R.I.) sponsor of the companion bill in the House, House Joint Resolution 370, made another important point

when, in introducing the measure on 6 May, he said: "This is not an aid program. It is not a welfare program. It is not comparable to commendable programs of this nature by which the United States assists others to improve their economic defense or welfare status. Thus the proposed new research program is one which exploits scientific potential alone." Repeatedly during the senate committee hearings it was stressed that the programs under the bill should not become obscured and confused by international politics and should be carried out on a scientist-to-scientist basis rather than as government-to-government negotiation.

Wide Public Support

The bill has had widespread support from the press and the public, and in May the National Conference on World Health, held in Washington under the auspices of the National Citizens Committee for the World Health Organization, devoted a major panel session to discussion of the measure. The session, "World Health for World Peace," was chaired by Howard A. Rusk, director of the Institute of Physical Medicine and Rehabilitation at the New York University-Bellevue Medical Center. Panelists John T. Connor (president of Merck and Company, Inc.) and John J. Powers, Jr. (president of Pfizer International, Inc.) reported that their companies—and, in fact, the pharmaceutical industry as a whole—favored passage of the bill. However, both men expressed the hope that the traditional pattern of division of responsibility between governmentally supported research and research and development conducted by private industry would continue to be observed. To this, panelist Thomas Parran, former Surgeon General of the U.S. Public Health Service and now president of the Avalon Foundation, replied that there has been no major conflict on this point in connection with the operation of the National Institutes of Health.

The nine panelists agreed unanimously on the need for increased federal support in all fields of international health, but they emphasized that this should not be at the expense of privately sponsored programs. Representative Walter H. Judd (D-Minn.), a physician and for 10 years a medical missionary in China, agreed that there was no substitute for personal, voluntary effort. Leo Gherne, executive director of the Research Institute of America and chairman of the International Rescue Committee, suggested that humanitarian intervention involving health services could often be more effective than military intervention in conflicts with the Soviet Union.

Senator Richard Neuberger (D-Ore.) reminded the audience that although the legislation had significant humanitarian

and diplomatic aspects, Americans should not lose sight of its "self-interest" aspects. After commenting that in his state, which ranks high "in the realm of literacy," his mail runs about ten-to-one against foreign aid, Neuberger urged his listeners to "convince your people that world health and our participation in it is in the interest of world peace. . . . I think we have to put flesh on the skeleton and to show that the people feel that they have an international stake in health. . . ." Then he emphasized that the new program might produce medical discoveries that would prevent death and extend the lives of many Americans. That the United States has no monopoly on scientific development—that major findings have often been made in unexpected parts of the world—was a recurring theme throughout the discussions.

Although most of the formal consideration of the "Health for Peace Act," both governmental and nongovernmental, has emphasized its apolitical character, many of the editorials on the measure have mentioned that the Soviet Union is winning gratitude in many areas of the world by providing medical aid, while in this country such aid is largely in the discussion stage. House hearings on the act have not been scheduled at this writing. However, now that Representative Fogarty is back from the World Health Organization meeting in Geneva, perhaps prompt action can be expected.

NATO Progress in Science

The North Atlantic Treaty Organization's Science Committee and Office of the Science Adviser were established a year ago and are now in full operation. Recently Norman F. Ramsay, scientific adviser to the secretary general of NATO, reported on the Science Committee's activities for the first year of its existence. He pointed out that the committee has studied means for strengthening science among the NATO nations and has already taken action.

Fellowships and Summer Institutes

The largest and perhaps most obvious of its actions is the establishment of the NATO fellowship program. Ramsay observed that since the end of the war there has been a need for more freedom of movement for scientists, both within Europe and reciprocally between Europe and the United States. There has also been a shortage of well-trained scientists. The North Atlantic Council, at the recommendation of the Science Committee, has established about 250 science fellowships, each to be used in a country other than that in which the applicant lives. This number is expected to rise to about 400 next year.

It should be noted that the Department of State and the National Science Foundation have recently announced the award of the first group of 20 NATO postdoctoral fellowships to Americans. The grants will enable fellows to attend institutions in Denmark, Germany, the Netherlands, Norway, Sweden, and the United Kingdom. Of the 20 awards, seven are for research in the life sciences and 13 are for research in the physical sciences, including mathematics and engineering. Each NATO fellow will receive a basic 12-month stipend of \$4500. In addition, limited round-trip travel and dependency allowances will be provided.

Another of the NATO Science Committee activities described by Ramsay is the encouragement of institutes and summer schools for study of advanced or special scientific subjects. The organization has now established a fund for the partial support of such institutes. Largely as the result of NATO support, there will be six institutes next summer and even more in subsequent years.

Other Plans Being Considered

Ramsay also said that the pooling of scientific facilities and information for various collaborative programs is under discussion, particularly in deep-sea oceanography, space exploration, and materials research. He pointed out that oceanographic research ships, for example, are too expensive for most NATO nations to finance separately, but not collectively. Furthermore, he added, even when ships are sponsored by individual nations, coordinated studies are more meaningful than separate ones.

Ramsay also suggested that another means by which NATO science might be advanced on a cooperative basis would be through establishment of a comparatively small fund that would be available to provide quick assistance to joint scientific projects that are held up because of lack of money. He explained that a project is sometimes short of special equipment which can only be bought with foreign currency. Ramsay emphasized that a fund available without delay to those who need help is "many times more valuable, price for price, than money that is laborious and slow to administer." He expressed the hope that such a flexible, speedily administered fund could soon be made available.

Defense Science Slowed by Secrecy

He observed that defense science is of obvious importance but that cooperation is often slowed down by secrecy. However, Ramsay commented that during the past year there has been spectacular improvement in the exchange of classified defense research information. He said: "The launching of the Russian Sputnik showed both that the NATO nations

could not afford such a waste of scientific effort and that the Russians had probably already discovered much of the information that the NATO nations were so zealously guarding from each other."

Ramsay's report closed with the following statement.

"The problem of science in the Atlantic Community remains a challenge. . . . Compared to the past, the scientific and technical cooperation now existing among the NATO nations is impressive. Yet compared to what is needed to be done, when we think of the swift advance of Russian research—even if Russia has yet to catch up with the West in most subjects—then our efforts are still too slow footed. The present is a beginning but the challenge still remains."

Kistiakowsky Succeeds Killian as Top Science Adviser

James R. Killian, Jr., President Eisenhower's top science adviser for the past year and a half, will leave government service next month. The former president of the Massachusetts Institute of Technology, who is both the President's Special Assistant for Science and Technology and the chairman of the new Federal Council for Science and Technology, will be succeeded, probably in both positions, by George Kistiakowsky, professor of chemistry at Harvard University. In his letter of resignation, Killian said that "compelling personal reasons" were the basis for his action. Replying to the letter, which was submitted 28 May, President Eisenhower said, "It would be impossible for me to overemphasize the importance of your work here. . . ."

Killian Had Major Role

One of the administration's responses after the first Soviet satellite launching in October of 1957 was the creation of a new post in the executive branch of the government. This position—Special Assistant for Science and Technology—was filled, with wide acclaim from the American scientific community, by Killian, who was then president of MIT. During the 18 months since his appointment, Killian, with the support of the Science Advisory Committee, has exerted a profound influence on the planning of this country's scientific efforts. Numerous reports, which, taken together, constitute a thorough review of the role of science in American society, have issued from the Killian committee. One of them, "Strengthening American Science," led to the establishment of the Federal Council for Science and Technology. Others have been concerned with the need for basic research, the role of

science in education, and the feasibility of an atomic test inspection system.

Will Stay on Committee

Killian will continue to be a member of the advisory committee. In this position he will be able to continue working with Kistiakowsky. The new special assistant, who, unlike Killian, is a noted research scientist, has been a member of the committee since 1957. He has served as one of the Administration's chief advisers on the ballistic missile program and has had rather extensive personal contact with the President in this position. He was also a member of the U.S. delegation at the technical talks on surprise attack held in Geneva in 1958.

The new adviser is said to have an outgoing personality and a well-developed sense of humor. Anecdotes about him mention that he frequently uses his skill with explosives to solve house-owner problems—for example, to clear land of stumps or to clean a neighbor's cement mixer.

Science Display at Soviet Exhibition

On 30 June the Soviet Exhibition will open at the Coliseum in New York. The large exhibition, which will run until 10 August will have a science section covering approximately 13,000 square feet, which will contain exhibits dealing mainly with the activities of the U.S.S.R. Academy of Sciences. F. R. Kozlov, a First Deputy Premier of the Soviet Union, will open the show, which is part of a cultural exchange between the United States and Russia.

Three large displays in the physics and mathematics section will provide information about important research work—for instance, the work of P. N. Cherenkov, a Nobel Prize winner. An operating unit will demonstrate the glow that he discovered. There will be instruments demonstrating other applications of research in physics, including a machine tool for supersonic treatment of hard and fragile materials. There will also be a display of the uses of transistors, notably a transistorized refrigerator model.

There will be a varied display on Soviet geological and geographic research. The extent of the Soviet Union's mineral riches and the ways in which these minerals are being uncovered will be illustrated in geological and tectonic maps and in collections of ores and minerals. The geographic section will have displays on the exploration of the earth's ice cover and the world oceans. There will be a model of the *Vityaz*, the famous "science ship" which has sailed thousands of miles across the oceans of

the world. The exhibits include cross sections of deepwater depressions plumbed by Soviet oceanographers, models of the huge underwater ridges they discovered, and models and drawings showing the strange sea animals caught by Soviet scientists. In addition, the geophysics section will show models of the standard-type seismic stations that were used for research under the International Geophysical Year program.

A special section will illustrate Soviet achievements in organic and inorganic chemistry and will demonstrate discoveries by Soviet scientists in the field of chain reactions and operating instruments used in observing the most delicate and complex chemical processes. The instruments include a mass spectrometer (an instrument for photographing fast-flowing processes at a speed of from 7 million to 33 million frames per second) and an electronic paramagnetic resonance unit. The exhibits devoted to theoretical and practical research in organic chemistry will demonstrate techniques for producing new chemical compounds and plastics, and artificial fibers made from these compounds.

The exhibitors have attempted to make the meaning of scientific research comprehensible to the layman. With this end in view, they have provided a large variety of charts, drawings, sketches, photographs, and color slides, to be shown on special screens. In addition there will be 12 science-fiction films. Also on display will be more than 100 instruments and devices developed by Soviet scientists, and many models.

A special section will be devoted to the work of the History Division of the U.S.S.R. Academy of Sciences. It will deal with historical and archeological subjects. This is the first time that Soviet historical research will have been represented at an international exhibition. A special display, in the form of a huge cylinder about 10 meters in diameter, will be set up, with models, drawings, maps, and so on covering its exterior. Upon entering this structure, visitors will find a well-lit and well-furnished library where they will be able to examine books by Soviet historians and Soviet historical magazines.

Report on Education in Age of Science

A report, titled "Education for the Age of Science," was issued 23 May by the President's Science Advisory Committee. It was written by a 9-man panel on science and engineering education. An accompanying statement by President Eisenhower, the panel's four sets of recommendations, and the panel membership follow.

President's Statement

This report makes clear that the strengthening of science and engineering education requires the strengthening of all education. As an excellent statement of educational goals and needs, I hope it will be widely read and that it will stimulate a wider understanding of the importance of excellence in our educational system.

One subject discussed in the report warrants special emphasis—the importance of raising the standing of our teachers in their communities. Higher salaries are a first requirement, but we need also to recognize the great importance of what teachers do and to accord them the encouragement, understanding, and recognition which will help to make the teaching profession attractive to increasing numbers of first-rate people.

Curriculum and Course Content

Curriculum. We urge the scientists and scholars of the country to establish more intimate contact with experienced teachers at all levels, so the curricula and the teaching and learning aids in schools, colleges and universities may take account of the new facts and the new points of view that scientific progress has revealed.

We further recommend that a research program be established by an appropriate foundation or agency in which scientists, scholars and teachers cooperate to design more adequate curricula planned to give to all educated citizens an adequate introduction to those areas of science and technology essential to an understanding of the problems of a modern society.

Course Content. We recommend that present efforts be aggressively pursued and substantially expanded in bringing together leading scientists, scholars and teachers in these various subject-matter fields to seek:

- 1) To bring the course content in each subject at each level into line with the most modern scholarly research in its field, consonant with the level of instruction.
- 2) To outline, write, publish, and revise the necessary textbooks and auxiliary reading materials to achieve the above objectives. We believe, in particular, that far more imagination and innovation is appropriate in the preparation, printing, illustrating and publication of textbooks—on the one hand, to produce much less expensive books in the basic fields so that a much larger number of students will be able to build their own libraries; and, on the other hand, to insure that all the resources of the modern publication art are brought to bear in the preparation of textbooks which are challenging, stimulating, and exciting.
- 3) To develop and supply adequate teaching and learning aids of all appro-

priate kinds, including motion pictures, television, tape recordings, slides, and other audio-visual materials designed to aid the student in understanding the subject more thoroughly, and especially to relieve the teacher of unnecessary burdens of preparation and instruction, and to enable the outstanding teacher to reach a much larger number of students.

4) To develop and supply laboratory equipment and materials for science courses together with the necessary manuals and reading materials to make the laboratory and field work a far more meaningful, useful and exciting aid to student and teacher.

The programs now being sponsored by the Carnegie Corporation, the Ford Foundation, the Alfred P. Sloan Foundation, and the National Science Foundation provide excellent preliminary efforts. They need very rapid and substantial expansion to cover other fields and other educational levels. The National Defense Education Act of 1958 recognized this need.

Quality and Effectiveness of Teachers

We recommend that:

1) Scientists and engineers in universities and industries seek to establish organized programs of collaboration with high school and college teachers in order to reduce the gap in communication and understanding between these groups, rendering assistance and providing teaching material to teachers and their students, and bringing high school and college students and teachers into more direct contact with scientific and scholarly work in universities and industry.

2) Efforts be continued and accelerated toward improving the economic and social status of teachers at all levels, and enabling them to devote more of their working time to teaching tasks rather than administrative chores, and allowing them more time for preparation and study in their chosen fields.

3) Private and government agencies evolve state and national programs for providing substantial rewards, prizes, and other recognition to outstanding teachers in both elementary and secondary schools.

4) A research program be sponsored by an appropriate foundation or agency and organized on a national scale to bring together a key group of scientists and scholars to collaborate with teachers and educators on the problem of designing more adequate curricula for the education of high school and college teachers, especially in the sciences and mathematics, with the aims of reducing the alleged conflict between subject matter and methodology, making teacher training programs more attractive to the best students, and bringing about a better understanding between scholars, sci-

entists, teachers, educators and the public in regard to the philosophy, goals, and methods of the educational system.

5) With the assistance and encouragement of our universities, the nation's best scholars join the nation's great teachers in the task of determining how the great teacher may be brought before an even larger number of students.

Recognition and Encouragement of Students

[We recommend] that we accept as a national goal lifting student performance to higher levels of excellence by greater motivation and by the provision of rewards for intellectual achievement and more adequate and extensive opportunities and challenges to the highly gifted student. To these ends we specifically recommend that:

1) A nation-wide effort be made to pay more attention to the academically talented students (that is, those in the upper 15 to 20 percent of their age group in intellectual ability) and to the unusually gifted students (that is, those in the upper 3 percent of the age group). Such an effort should involve citizens, schoolboards, parents, teachers, together with state and national agencies, public and private. Talented students should be recognized at an early age and given guidance and counsel in planning their educational programs and in preparing for and choosing college and university work.

2) These gifted students be given necessary help in financing their educational programs in high school as well as in college and in graduate school.

3) Such students be rewarded and encouraged for their achievement in order that they may take pride in intellectual excellence, even at an early age.

4) Programs of prizes and scholarships be extended into the high school level so that students even in remote and rural communities are enabled to attend high schools which will provide opportunities commensurate with their abilities.

5) Public and private agencies combine to offer on a national basis a much larger number of prizes than now exist to high school students for unusual intellectual achievement in important subject-matter fields.

Development of Intellectual Leadership

We specifically recommend that:

1) The curricular revision program now being developed for high school science courses be extended to undergraduate college courses in science and mathematics.

2) Aid be rendered to liberal arts colleges in examining their curricular to assure that they are adequately providing for scientific education of the non-scientist as well as of the future scientist or engineer.

3) We accept as a national goal improving the number and quality of our schools of science and engineering.

4) University graduate schools in science and engineering be enlarged in number and improved in quality, and especially that far greater emphasis be placed upon graduate work in engineering.

5) The engineering colleges of the country collaborate to improve and modernize their offerings in all engineering fields to insure that able students are attracted to these fields and that they are given adequate training to meet the engineering and technological problems of tomorrow.

6) Government agencies concerned with research in science and engineering re-examine the terms of their research support to educational institutions with a view to avoiding placing a financial burden or penalty on such institutions by reason of inadequate coverage in research contracts or grants of costs properly chargeable as overhead and for management allowances. Without serving as a subsidy in any way, proper handling of these fiscal matters can make certain that the research support will not affect adversely the opportunity to use the research effectively for the education of students, for the attraction and retention of able faculty members, and for the release of teachers and students from burdensome administrative and fiscal restrictions.

Membership of Panel

John E. Burchard, dean, School of Humanities and Social Studies, Massachusetts Institute of Technology.

Henry Chauncey, president, Educational Testing Service.

Caryl P. Haskins, president, Carnegie Institution of Washington.

Frederick C. Lindvall, chairman, Division of Engineering, California Institute of Technology.

James A. Perkins, vice president, Carnegie Corporation.

Alan T. Waterman, director, National Science Foundation.

Dael Wolfe, executive officer, American Association for the Advancement of Science.

Jerrold R. Zacharias, professor of physics, Massachusetts Institute of Technology.

Lee A. DuBridge, president, California Institute of Technology (chairman).

Consultants to Panel

Harold B. Gores, president, Educational Facilities Laboratories, Inc.

S. C. Hollister, dean, College of Engineering, Cornell University.

Frederick L. Hovde, president, Purdue University.

Stephen White, director, Film Division, Educational Services Incorporated.

Science Academy Gift

A gift from the Equitable Life Assurance Society of the United States for the construction of a new wing of the National Academy of Sciences building in Washington, D.C., was announced last month. The gift will provide for the erection of the Equitable Life Assurance Society Hall of the Life Sciences, in which will be housed the many scientific activities of the academy and its National Research Council in the fields of biology and medicine.

Architects for the new hall will be Harrison and Abramovitz, who have been associated with the design of many buildings, such as Rockefeller Center, the Lincoln Square project in New York, and the United Nations building. Harrison, senior member of the firm, was as a young man associated with Bertram Goodhue in the design of the present academy building.

When the academy's building was erected in 1924, it was planned to accommodate additional wings as the need developed and funds became available. With the greatly increased scope of the academy's work, more space has been urgently needed and many activities of the Academy-Research Council have had to be housed in widely scattered locations throughout Washington.

Detlev W. Bronk, president of the academy, made the following comment on the gift: "Erection of this new hall of the academy to house the medical and life sciences will be of great value to our nation. It is eminently appropriate that the Equitable Life Assurance Society thus contribute to the work of the academy, for we are both private organizations devoted to the public welfare."

Thermonuclear Research Progress Slow

Leading atomic scientists from many countries, including the U.S., Germany, France, the U.S.S.R., Sweden, Belgium, and Italy, met in London last month to discuss the problems of thermonuclear processes. The 2-day conference on the study of the release of energy by fusion of the nuclei of light elements was the first meeting on the subject to be held in Britain. The convention was arranged by the Institution of Electrical Engineers in conjunction with the British Nuclear Energy Conference.

B. F. J. Schonland, director of the Atomic Research Establishment at Harwell, opened the meeting by pointing out that while there is no need for undue pessimism about the outcome of experimental thermonuclear work, there is little point at the moment in talking of a thermonuclear reactor. Schonland reviewed the present position of research work and said:

"It became clear in the course of 1958—and crystal clear after the Geneva [Atoms for Peace] Conference—that in spite of much brilliant theoretical, experimental and engineering work, no one in the world had yet succeeded with certainty in the very first stage of producing a true, controlled thermonuclear reaction. The emission of neutrons from these devices has been in most cases only an index of plasma instability."

After the opening address a correspondent asked Schonland if research in this field is still very promising. Schonland replied:

"It has become clear that we are going to have success in this field only if we multiply the research needed to get an understanding of it. . . . Though every-

body believes we shall solve the problem, I cannot hazard a guess as to when. It will take longer than we first thought, but there's general agreement that there is no race in this business. It is friendly cooperation that is needed."

He went on to say that cooperation with America and other countries is very close, but that since the field is completely unrestricted, there is no limit to cooperation with other countries by means of information exchanges and two-way visits.

Asked if he thought it necessary to modify in any way Sir John Cockcroft's prediction that power from thermonuclear reactions would be a reality in "twenty years plus," Schonland said: "I think the work of the last year has shown it would be a matter of extreme good fortune if we could reach the power stage in twenty years. But we might have luck . . ."

Teaching by Television

More than half a million American students, from the first grade through college, are receiving part of their classroom instruction by television, according to a joint report, *Teaching by Television*, that has been published by the Ford Foundation and the Fund for the Advancement of Education. As of 1 February, 117 colleges and universities offered courses for credit on television, 569 school districts made regular use of televised instruction, and 241 colleges and universities offered credit for the nationwide television course in modern physics, "Continental Classroom."

The report describes educational-television experiments that have been supported by the Ford Foundation and the Fund for the Advancement of Education involving more than 25 colleges and universities and 100 school systems and more than 100,000 students and their teachers. During the past 5 years, the Fund and the Ford Foundation have provided financial support amounting to more than \$10 million for more than 50 different experiments at the school and college level involving the use of television as a medium of instruction. The report points out that practically every course in the school and college curriculum, from first-grade arithmetic to college zoology, is being taught somewhere over television.

The new publication presents the following results from the experiments:

- 1) Two of the most extensive school experiments (Washington County, Md., involving some 18,000 students, and the National Program in the Use of Television in the Public Schools, a nationwide project involving in its first year nearly 40,000 students in more than 100 public-school systems) indicate that superior



Academy of Sciences addition: Proposed new wing (left) of the National Academy of Sciences building in Washington is shown in architect's drawing. The wing will be called the Equitable Life Assurance Society Hall of Life Sciences in honor of the company which is providing the funds for its construction.

teaching over television results in much better learning on the part of the student than ordinary teaching in the classroom.

2) Televised instruction requires the student to accept more responsibility for his own learning than is the case with conventional methods of instruction.

3) Students in television classes at the elementary and secondary level make more extensive use of the school library than students in regular classes.

4) Televised instruction has made possible more effective use of teaching time and classroom space.

5) The use of superior teachers on television has proved an important means of improving the teaching techniques of other teachers, particularly beginning teachers.

The report closes with the following statement:

"Television is not a panacea that will cure all the ills of American education or solve all its problems. It has been described, and rightly so, as the most important new educational tool since the invention of movable type, but like the textbook the new medium is essentially just that—a tool. Like any tool, it can be misused or badly used. But if it is wisely and imaginatively used, television can play a major role in broadening and enriching the education of American students at all levels of schooling."

Copies of *Teaching by Television* are available without charge from the Office of Reports, Ford Foundation, 477 Madison Ave., New York 22, N. Y.

British Association to Meet in Fall

The British Association for the Advancement of Science will return to York, the city in which it was founded, for its 121st annual meeting, to be held 2-9 September. The York meeting, at which approximately 3000 members will convene, will take its theme from the presidential address of Sir James Gray titled "The Proper Study of Mankind is Man."

Other addresses will be given by the presidents of the various sections of the association. In addition, Michael Swann will speak on "The Unseen Pattern of Growth," and Sir William Hildred will comment on "International Air Transport Problems."

A program of illustrated lectures for young people from schools in the York area will be offered during the meeting. A theater will present a continuous showing of scientific films. The program committee has also arranged for a number of visits and excursions to commercial and industrial concerns and to places of historical interest in York and the surrounding area.

Study of Pregnancy

Prospective mothers are now being chosen to take part in a 5-year study to evaluate causes of neurological and sensory disorders that arise during pregnancy and shortly after the birth of the baby. Sixteen medical centers across the nation are collaborating in the project, with the National Institute of Neurological Diseases and Blindness as the coordinator and central laboratory. The study will eventually include some 40,000 mothers and their infants; each case will be followed until the child is 6 years old.

All unusual events during pregnancy will be carefully documented. Should a neurological disorder develop in the infant, an attempt will be made to correlate it with events and conditions of pregnancy, birth, or infancy. As causes are discovered, they may point the way to means of preventing cerebral palsy, mental retardation, blindness, and deafness.

The 16 medical centers comprising the study are located in Boston, Providence, New Haven, New York, Buffalo, Philadelphia, Baltimore, Richmond, Memphis, New Orleans, Minneapolis, Portland (Ore.), and San Francisco.

Two Exchanges of Professors with Russia May Begin

Both Harvard and Columbia universities are working on plans for an exchange of professors with universities in the Soviet Union. Harvard, which would have a limited exchange with Leningrad State University, hopes to start its program by the beginning of the academic year, in September. Columbia hopes to begin in February of next year.

The two programs will differ in that the Harvard-Leningrad project will be mainly an exchange of research workers, whereas the Columbia program is expected to place more emphasis on teaching. Both programs are still described as "tentative," and both are expected to involve only a few professors. The exchanges now being negotiated were originally viewed as one part of an overall Soviet-American cultural exchange agreement concluded early last year.

Materials Research Committee Appointed by Academy

The National Academy of Sciences-National Research Council has announced the appointment of a 14-man committee to determine how materials research and development in the United States can be accelerated to meet the increasing demands of industrial progress and of national defense. The Committee on the Scope and Conduct of

Materials Research has been asked (i) to determine how more rapid and effective progress in materials research can be realized through increased financial support, administrative or organizational steps, improved coordination of effort or other means; (ii) to consider both basic and applied research carried on for both defense and nondefense purposes in governmental, industrial, academic, and other research institutions; and (iii) to consider the resources of raw materials, personnel, and facilities.

Clyde Williams, president of Clyde Williams and Company of Columbus, Ohio, is chairman of the committee. A former president and director of Battelle Memorial Institute, he also served as chairman of the War Metallurgy Committee of the Academy-Research Council during World War II.

Film on Nutrition in Africa

A special documentary film that shows the work of United States nutrition survey teams in Ethiopia has been made. The 25-minute color film, entitled *People to People* was produced by the Government's Interdepartmental Committee on Nutrition for National Defense, whose secretariat is located at the National Institutes of Health. Early in 1956 this committee launched a nutrition program for the purpose of assisting developing countries, as a part of the U.S. Mutual Assistance Program. *People to People* is the story of the ninth nutrition survey.

The survey team spent 3 months in Ethiopia and traveled more than 10,000 miles on the ground and in the air. Nearly 9000 Ethiopians were examined by the physicians, biochemists, and food specialists on the team. The film shows how the surveys are carried out and illustrates the typical living conditions, agricultural practices, modes of transportation, and medical and educational facilities available.

Science Council Members Briefed

The members of the new Federal Council for Science and Technology are currently being briefed on the scientific activities of each of the governmental agencies represented on the council. These agencies are the National Science Foundation, the Atomic Energy Commission, the National Aeronautics and Space Administration, and the departments of Defense, Interior, Commerce, Agriculture, and Health, Education, and Welfare. Representatives of each of these agencies are giving brief reviews of the scientific activities which take place within their department. One such statement was recently released by the council. It was presented

by E. L. Peterson, Assistant Secretary of Agriculture, Department of Agriculture representative. Peterson discussed the role of research in U.S. agriculture, the demands of agricultural research in the next 50 years, research coordination in the department, relation of USDA research programs to those of other federal agencies, and current problems in the management of research.

AEC Calls for Limited State Role

A member of the Atomic Energy Commission told the Joint Atomic Energy Committee that the time had come in the growth of the atomic energy industry to "readjust" the regulatory responsibilities between the federal and state governments. Describing proposed legislation, Commissioner John S. Graham said that the AEC would favor transfer to the states of some of its licensing authority for control of radiation hazards. The legislation which the commission has proposed would give the states responsibility for protecting public health in the fields of ownership and use of radioactive by-products, including radioactive isotopes; ownership and use of uranium and thorium ores; and possession and use of nuclear materials such as enriched uranium and plutonium. Under the legislation these nuclear materials would be limited to amounts smaller than the critical masses that are needed for a nuclear chain reaction.

Responding to questions from committee members, Graham said that there were a number of states that were prepared to move forward rapidly if authorizing legislation were passed.

Panel Drafts International Convention on Nuclear Hazards

Agreement on the main points of a draft international convention on civil liability and state responsibility for nuclear hazards has been reached by a panel of experts convened in Vienna by director-general Sterling Cole of the International Atomic Energy Agency. The group, consisting of ten experts from as many countries, decided to meet again in the summer to discuss matters on which there is not yet agreement and to prepare its final report.

Aspects of a convention on which the experts reached a large degree of unanimity include the need for minimum international standards regarding the limitation of liability and the absolute nature of such liability. A flexible formula was devised to make it possible to achieve a wide acceptance of the convention, and it was recommended that the state would have to assume subsidi-

ary liability in cases where established limits were lower than those recommended as international minima.

Substantial agreement was also reached on questions concerning liability for transportation and waste disposal of radioactive materials and nuclear fuels.

The panel unanimously recommended that courts of the state in which nuclear installations are located should be exclusively competent to hear any claims for damages resulting from nuclear incidents; these courts would apply their own domestic law.

Concerning international transport, the courts of the state in whose territory an accident occurred would be the competent ones.

The first session of the panel was held in February 1959. Members who attended the second session, just concluded, were Paul Ruegger (Switzerland), chairman; Giuseppe Belli (Italy), C. H. Carruthers (United Kingdom), Edward Diamond (United States), Yoshio Kanazawa (Japan), B. N. Lokur (India), Anatol Nikolaiev (U.S.S.R.), Fuad Abdel Moneim Riad (United Arab Republic), Pavel Winkler (Czechoslovakia), and Enrique Zaldívar (Argentina).

Tenth Edition of "American Men of Science"

Editorial work on the tenth edition of *American Men of Science* is now in progress on the campus of Arizona State University in Tempe, Arizona. Biographies of more than 120,000 living Americans and Canadians who are actively contributing to the advancement of science will appear. Details will include the name, position, address, field, birthplace, degrees, positions held, memberships, and research specialties of each individual listed.

The directory will be put out in a different form than that of previous editions. The editor has found it possible, following the recommendation of an advisory committee, to publish the entries for the physical and biological sciences alphabetically in four volumes, to appear over a period of 3 years; these will be followed by the volume for the social and behavioral sciences. The publication of the A-E volume for the physical and biological sciences is well under way. The questionnaires for the physical and biological sciences have been mailed, so that everyone has had an opportunity to make nominations.

Anyone who was previously included in *American Men of Science* and who has not received a questionnaire should immediately write to Jaques Cattell, Editor, *American Men of Science*, Arizona State University, 820 College Avenue, Tempe, Arizona.

News Briefs

The Air Force School of Aviation Medicine will move from Randolph Air Force Base, near San Antonio, Texas, to new, multimillion-dollar quarters southwest of the city, beginning in July. To date, the Government has taken possession of three of the seven buildings comprising the new institution. They are the Flight Medicine Laboratory, the Academic Building, and the Research Laboratory Shops. The Research Institute Building, which will house the school's headquarters, is to be accepted in mid-June; the Heating-Cooling Plant and Altitude Laboratory, in July.

According to Maj. Gen. Otis O. Benson, Jr., commandant of the School of Aviation Medicine, movement of personnel and equipment to these facilities is tentatively scheduled to begin on 13 July.

* * *

A preliminary assistance mission of the International Atomic Energy Agency left Vienna last month for a tour of five member states in the Far East: China (Taiwan), Japan, Korea, the Philippines, and Viet-Nam. This is the second such mission to be sent out by the agency this year; the first visited Burma, Ceylon, Indonesia, and Thailand. The mission to the Far East, which is headed by Harold Smith of IAEA's Division of Isotopes, is expected to return to Vienna in early July.

* * *

Three U.S. Office of Education specialists are visiting in Russia and Poland to observe methods of training elementary and secondary school teachers in the fields of mathematics, science, and industrial arts. The team is spending a month in the U.S.S.R. and a week in Poland. The travelers are William K. Medlin, Marshall L. Schmitt, and Clarence B. Lindquist, who will return to Washington late in June to prepare a report.

* * *

The Institute for Research in Hypnosis, established by a charter from the Education Department of the State of New York, has opened its new headquarters at 33 E. 65th St., New York, N.Y. The institute is a nonprofit educational corporation organized to sponsor education and research in clinical and experimental hypnosis.

* * *

The Deafness Research Foundation has announced initial grants of \$13,240,000 from foundation funds for basic research in hearing and deafness. The foundation, established less than a year ago, is the only national voluntary health organization founded and governed by laymen that is devoted primarily to fundamental research on the causes, prevention, and cure of deafness.

Grants, Fellowships, and Awards

Foreign study. U.S. Government Fulbright Awards for university lecturing and advanced research in 1960-61 in Europe, the Near East and Africa, and the Far East have been announced by the Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C. The closing date for receipt of applications is 1 October 1959.

Life sciences. The division of biological and medical sciences of the National Science Foundation has announced that the next closing date for receipt of basic research proposals in the life sciences is 15 September. Proposals received prior to that date will be reviewed at the fall meetings of the foundation's advisory panels, and disposition will be made approximately 4 months after the closing date. Proposals received after 15 September will be reviewed following the spring closing date of 15 January 1960. Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

Monograph prizes. The American Academy of Arts and Sciences has announced a program of Monograph Prizes. These \$1000 annual prizes are a new addition to the academy's 180-year old tradition of support and publication of scientific and scholarly research. It is hoped that the judgment of merit by the academy will stimulate publication of significant monographs in the fields of the humanities, the social sciences, and the physical and biological sciences. To evaluate the manuscripts submitted, a nine-man committee of fellows of the academy has been established, with three members for each of the three fields in which prizes are to be awarded.

A monograph is defined for the purposes of these awards as a "scholarly contribution to knowledge, too long for an article in a learned journal and too specialized or too short for a general book." Recipients of these prizes will be expected to make their own arrangements for publication. The final date in 1959 for receipt of manuscripts by the committee on awards is 1 October. Announcement of the awards will be made in December. Further information may be obtained from the Committee on Monograph Prizes, American Academy of Arts and Sciences, 280 Newton St., Brookline Station, Boston 46, Mass.

Nuclear science. The European Nuclear Energy Agency of the Organization of European Economic Cooperation has arranged with the Atomic Energy Research Establishment at Harwell (United Kingdom) and the Centre d'Etudes Nucleaires at Saclay (France) for presentation of two international courses on nuclear energy. Designed for the teach-

ing staffs of universities and higher technical colleges, each course will accept about 50 applicants, who will have the opportunity to study the latest advances in nuclear science and techniques, to do certain practical work, and to visit nuclear installations.

The costs of these courses, both of which will run from 20 to 31 July, are being borne by the European Nuclear Energy Agency, and participants will only be required to pay travel and living expenses. Further information can be obtained by writing to the O.E.E.C. European Nuclear Energy Agency, 38 Boulevard Suchet, Paris 16^e.

Scientists in the News

The highest academic officers of six of the oldest universities in the Western World, and JOHN D. ROCKEFELLER, JR., received honorary doctor of laws degrees from Detlev W. Bronk, president of the Rockefeller Institute, at the institute's first academic convocation on 22 May. Those honored include: GIUSEPPE G. FORNI, rector of the University of Bologna, Italy, and professor of surgery; THOMAS S. R. BOASE, president of Magdalen College and vice chancellor of Oxford University, and an authority on the history of art; Baron EDGAR D. ADRIAN, master of Trinity College and vice chancellor of Cambridge University, and neurophysiologist, who received the Nobel Prize in medicine in 1952; JOSE L. BARANDIARAN, rector of the University of San Marcos of Lima, Peru, and an authority in the fields of civil law and the philosophy of law; NABOR C. FLORES, president of the National University of Mexico, a civil engineer and a specialist in soil mechanics; and NATHAN M. PUSEY, president of Harvard University.

The U.S. Department of Agriculture's Distinguished Service Award was presented on 26 May to each of the following scientists:

LEONARD I. BARRETT, staff assistant in the Division of Program Planning and Special Projects of the Forest Service, for his contributions to the planning and conduct of one of the most comprehensive nationwide surveys and appraisals of the nation's timber resources ever made.

HARRY A. BORTHWICK, chief scientist in the Pioneering Research Laboratory for Plant Physiology, Agricultural Research Service, Beltsville, Md., for his contributions to the understanding of the effect of light on the biological response of plants.

ARNOLD C. ORVEDAL, chief of the world soil map project of the Soil Conservation Service, Beltsville, Md.,

for the development of unique worldwide terrain intelligence maps and interpretative information of highest importance to the defense of the United States.

WALLACE B. VAN ARSDEL, assistant director of the Western Utilization Research and Development Division, Albany, Calif., for his pioneering research in time-temperature tolerance in the processing, storage, and marketing of frozen foods.

ARKADY N. RYLOV, chief, division of training of engineering and scientific specialists, Central Atomic Energy Utilization Board of the Council of Ministers of the U.S.S.R., and professor of the Moscow Bauman Higher Technical School, has been appointed deputy director general in charge of the Department of Training and Technical Information of the International Atomic Energy Agency. He succeeds V. V. MIGULIN, who is deputy dean of the faculty of physics of Moscow University, in charge of scientific research and training of postgraduate students.

STEPHEN W. KUFFLER, professor of ophthalmic physiology and biophysics at the Johns Hopkins Medical School, has been appointed professor of neurophysiology and neuropharmacology in the Harvard Medical School's department of pharmacology.

ROBERT E. STOWELL, professor and chairman of the department of pathology and oncology and director of cancer research at the University of Kansas Medical Center, has been appointed scientific director of the Armed Forces Institute of Pathology, Washington, D.C.

DONALD L. McKERNAN, director of the Bureau of Commercial Fisheries, U.S. Fish and Wildlife Service, has been named chairman of the World Scientific Meeting on the biology of Sardines and Related Species that is to be held in Rome, Italy, 14-21 September. The meeting is being sponsored by the Food and Agriculture Organization of the United Nations. MARIO RUIVO of Portugal is conference vice chairman.

DANIEL BERGSMA, state commissioner of health of New Jersey and former president of the Association of State and Territorial Health Officers, has been appointed associate director of medical care for the National Foundation, New York, effective 1 July.

HUBERT M. JAMES, professor of physics at Purdue University, has been appointed head of the University's physics department. He has been acting head of the department since the death of Karl Lark-Horovitz.

WILLIAM H. FISHMAN, research professor of biochemistry at Tufts University School of Medicine and director of cancer research at the New England Center Hospital in Boston, Mass., is lecturing in Japan on invitation from the Japanese Biochemical Society, the Japanese Cancer Society, and the Japanese Pharmaceutical Society.

EVAN JUST, president of International Drilling and Water Company, Inc., New York, has been appointed professor and head of Stanford University's department of mineral engineering, effective next fall.

ROBERT M. BUCHER, associate dean of Temple University's School of Medicine, has been appointed dean, effective 1 July.

Major General **ELBERT DECOURSEY**, commandant of the Army Medical Service School and clinical professor of pathology at Baylor College of Medicine, has been named director of the Southwest Foundation for Research and Education, San Antonio, Tex. He has also been appointed professor and director of scientific research at Trinity University in San Antonio.

The following scientists received Military Engineering Achievement awards during the 39th annual meeting of the Society of American Military Engineers.

WILLIAM K. CLOUD, chief of the Seismological Field Survey, Coast and Geodetic Survey, San Francisco, Calif., received the Colbert Medal.

HAROLD K. KELLEY, deputy director for construction, Directorate of Civil Engineering of the Air Force, received the Newman Medal.

Lt. Comdr. DONALD GROTE ISELIN, assistant officer in charge of the Naval Civil Engineer Laboratory at Port Hueneme, Calif., received the Morell Medal.

DONALD E. EPPERT, area engineer under the Jacksonville Engineer District of the Corps of Engineers, U.S. Air Force, received the Wheeler Medal.

ERIC A. WALKER, president of the Pennsylvania State University, received the Bliss Medal.

WALKER L. CISLER, president and director of the Detroit Edison Company, received the Goethals Medal.

Lt. Gen. RAYMOND A. WHEELER, U.S. Army, retired, former president of the society, received the Toulmin Medal for his article "Clearing of the Suez Canal."

Rear Adm. LEO O. COLBERT, U.S. Coast and Geodetic Survey, retired, and **Major LEX E. O'BRIENT**, assistant professor of military science and tactics at the Colorado School of Mines, each received the Gold Medal.

J. E. HAWKINS, professor of chemistry and director of research on naval stores at the University of Florida, has received the 1959 Florida Section Award of the American Chemical Society.

JEAN ROUCH, anthropologist at the Musée de l'Homme, Paris, France, and outstanding film maker, will be a participant in the 5th annual Robert Flaherty film seminar, to be held 16-22 August at the University of California, Goleta.

HENRY DEWOLF SMYTH, Joseph Henry professor of physics at Princeton University, has been appointed chairman and dean of the university's newly established research board. The board was formed to establish policy in the acceptance and administration of research grants and contracts. It replaces the 12-year-old Committee on Project Research and Inventions.

ENRICO BOMPIANI, director of the institute of mathematics at the University of Rome, Italy, has been appointed Andrew Mellon professor of mathematics at the University of Pittsburgh. Bompiani is also professor of analytic and descriptive geometry and professor in charge of the chair of differential geometry at the University of Rome.

ROBERT M. JONES, technical consultant for the nuclear division of AFC Industries, Washington, D.C., has been named assistant manager of Lockheed Nuclear Products, Marietta, Ga.

Recent Deaths

ERNEST A. BACK, Chaplin, Conn.; 78; entomologist who contributed to the eradication of the citrus fruit fly; retired in 1947 after 40 years with the Bureau of Entomology of the U.S. Department of Agriculture; 22 May.

DUDLEY A. BUCK, Winchester, Mass.; 32; assistant professor of electrical engineering at Massachusetts Institute of Technology; developed the cryton, a small replacement for the transistor; 21 May.

FLOYD H. EGGERT, Sturtevant, Wis.; vice president of Werner Laboratories, Sturtevant, Wis.; 1 May.

HANS HEER, Westfield, N. J.; 62; chemist with the General Aniline and Film Corporation for more than 30 years; 23 May.

STANLEY JOHNSON, New York; 46; projects engineer with the Polytechnic Research and Development Corporation, Brooklyn; pioneer in the development of equipment for measuring microwaves; developed a portable version of the maser oscillator; 24 May.

ALSON R. KILGORE, San Francisco, Calif.; 71; chief surgeon with the Western Pacific Railroad for 25 years; former chief of surgery at Children's Hospital, and chief of staff at St. Joseph's Hospital; had taught at the Harvard Medical School in China; founder of the American Board of General Surgery, the California Physicians Service, and the Public Health League of California; 20 May.

JOHN C. LINCOLN, Phoenix, Ariz.; 92; founder of the Lincoln Electric Company of Cleveland, of which he was president from 1905 to 1928 and board chairman until 1954; president of the Bagdad Copper Corporation; president of the Henry George School of Social Science; developed the variable speed motor; 25 May.

KARL W. MEISSNER, Lafayette, Ind.; 68; spectroscopist, noted for his development of the atomic beam light source; professor of physics at Purdue University since 1943; director of the physics department of the University of Frankfurt am Main, Germany, until 1937; 13 Apr.

LOUIS N. RIDENOUR, Jr., Washington, D.C.; 47; noted research physicist; vice president of Lockheed Aircraft Corporation and general manager of its Electronics and Avionics Division; had been first chief scientist of the Air Force; composed the *Ridenour Report* that led to the establishment of the Air Research and Development Command; assistant director of the Massachusetts Institute of Technology Radiation Laboratory during World War II, when he developed airborne radar and radar-bombing systems; had taught at Princeton University and at the University of Pennsylvania, and had been dean of the University of Illinois Graduate College; author of *Modern Physics for the Engineer*; 21 May.

GEORGE SMOLAK, Somerville, N.J.; 59; research chemist and manager of the Johns-Manville Pipe and Board Department; former research chemist with the General Electric Company, Schenectady, N.Y.; 11 Apr.

FREDERICK TATTERSFIELD, Harpenden, England; 78; former head of the department of insecticides and fungicides, Rothamsted Experimental Station; 1 May.

WILLIAM H. WRIGHT, Mount Hamilton, Calif.; 87; director emeritus and astronomer emeritus of the Lick Observatory of the University of California; 16 May.

YAYOI YOSHIOKA, Tokyo, Japan; 88; Japan's first woman physician and founder of the Tokyo's Women's Medical School, now Tokyo's Women's Medical College, of which she was president and where she taught for more than 50 years; helped to establish hospitals in Tokyo; 23 May.

Book Reviews

Can Man Be Modified? Jean Rostand.

Translated from the French by Jonathan Griffin. Basic Books, New York, 1959. 105 pp. \$3.

"Have not the biologists the right to a little conceit, when they add up what they have achieved in the space of a mere half century?" asks Rostand, as he proceeds to catalog many of these achievements and predict future ones: parthenogenesis, sex control, chemical control of personality, artificial insemination, preservation of choice human sperm for long periods of time, modification of brain function, and so forth. The picture is familiar: it is *Brave New World* again.

It has been more than a quarter of a century since Aldous Huxley made his synthesis of implications. The evidence of his success is the extent to which subsequent writers in the same field have found it impossible to go beyond what he said. They may praise him or damn him, but they cannot, apparently, be very original. Some plagiarize *Brave New World* unconsciously, supposing they are saying something new. Others, more perceptive, generously acknowledge their debt, as Rostand does. A critic might protest against the repetition of ideas, but this reaction is probably wrong. Truth in human affairs has a sort of "half-life"—of ten years, say?—and it is necessary to revive truth periodically, to recharge its source, so to speak. The generations of mankind succeed one another rapidly, and the continuance of society requires endless repetitions, however painful they may be to the critic of long memory. He will just have to suffer.

Rostand is intransigently optimistic about the changes made possible by science and technology. Why, he asks, should we fear such developments as those that give us more leisure? "This is really like being afraid that a wife may become too beautiful, and I agree with Raymond Queneau . . . that 'the people who whine about naughty robots and inhuman machinery have never proved anything except their own lack of imagination and fear of liberty.'" With respect to the biological frontier, Rostand is delighted to report: "The fertilising needle enters into morals, it is provided for and paid for under social insurance,

and already one receives pieces of pasteboard with such inscriptions as: 'Mlle X has the pleasure of announcing the birth of her daughter [or son] by artificial insemination.'" This appears to be a statement of French fact rather than a prediction. It came as a surprise to me; I have not yet received any such formal announcement (but would be most delighted to see one).

Can Man Be Modified is a gracefully written book, with a bit of the *épatez les bourgeois* spirit in it that the French, from long experience, can manage so well. Yet it is basically serious, as Rostand insists, near the end: "We who are called 'scientists'—and it is a name we do not refuse, for there are less honourable ones—are not as grossly and naively insensitive as people are apt to believe. The fact that we persist in regarding man as part of nature does not make us have less respect for him or incline us to treat him without ceremony. I will even go so far as to say that perhaps respect for mankind should be even greater in those who believe only in man,—in those who, stripped of every illusion about transcendence, can only see in man an animal unlike any other, with no obligation except towards itself, with no law to obey except its own and with no values to revere except those of its own making."

GARRETT HARDIN

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Theory of Relativity. W. Pauli. Translated from the German by Gerald Field. With supplementary notes by the author. Pergamon, New York, 1958. xiv + 241 pp. \$6.

This book presents a comprehensive and critical discussion of both the special and the general theory of relativity. The discussion first appeared in 1921, in German, as an extensive contribution to volume 5 of *Encyklopädie der Mathematischen Wissenschaften*. Because of its excellence, and in view of the great interest in the relativity theory at that time, Sommerfeld arranged for its immediate publication in separate book form. Now, thanks to Gerald Field's

translation and to Pergamon Press, we are privileged to welcome Pauli's article, extended by him with extensive notes on developments between 1921 and 1956, into the English literature.

The many virtues of Pauli's discussion were eloquently proclaimed by the creator of the relativity theory, Albert Einstein, writing (in German) in *Naturwissenschaften* [10, 184 (1922)]: "It would be difficult for anyone who studies this mature and beautifully constructed work to believe that the author is a man of 21 years. One doesn't know what to admire most, the psychological appreciation for the development of ideas, the sureness of the mathematical deduction, the deep physical insight, the faculty for a clearly arranged systematic presentation, the knowledge of the literature, the factual completeness, or the sureness of criticism."

Part 1 (20 pages) contains a critical and thorough analysis of the empirical basis, and of important tests, of the special theory.

Part 2 (50 pages) is devoted to a complete and general discussion of the mathematical tools of the special and the general theory. Variational theorems, the theory of invariants, parallel displacement, and covariant differentiation in affinely connected, as well as Riemannian, spaces are a few of the topics covered. This part is of especial value to the serious student of the general theory.

Part 3 (71 pages) presents an exhaustive exposition of formal developments, including action principles, and of physical applications of the special theory to mechanics, electrodynamics, and thermodynamics.

Part 4 (42 pages) is concerned with the general theory. It presents a full discussion of the basic ideas of the equivalence principle and of general covariance and considers applications of the theory to special problems. In this part one first realizes how long ago this book was written. It is only in the supplementary notes that one finds a discussion of Friedmann's solution (1922) to the field equations for a world with a time-dependent metric and of the significance of this work for the cosmological problem, following the discovery of the red shift by Hubble. Also, the extensive work of Einstein, Infeld, and their collaborators in obtaining the law of motion of a particle from the field equations, with no additional assumptions, is only briefly referred to and discussed.

Part 5 (22 pages) is devoted to attempts to formulate an electromagnetic theory of mass within the framework of the special theory and to Weyl's attempt to incorporate electromagnetism in the world geometry, along with gravitation. Other, more recent, attempts to arrive at a unified field theory, by Einstein and by Kaluza and Klein, are discussed and

analyzed in the supplementary notes.

This book achieves a very broad coverage of subject matter in a limited space by confining formal developments to the main points, without presenting detailed proofs. In concluding his review of the original edition, Einstein recommended Pauli's treatment to "everyone working creatively in the field of relativity as well as to everyone who wants an authoritative orientation in fundamental questions."

Another of Pauli's legacies to modern physics is his equally highly esteemed article on "The general principles of wave mechanics," in the *Handbuch der Physik* [(Springer, Berlin, 1958), vol. 5, part 1]. It would be of at least equal value to the large community of monolingual American physicists if this, too, were to find its way into English.

SIDNEY D. DRELL

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Aircraft and Missile Propulsion. vol. 1, *Thermodynamics of Fluid Flow and Applications to Propulsion Engines*. 538 pp. Illus. \$11.50. vol. 2, *The Gas Turbine Power Plant, Turboprop, Turbojet, Ramjet, and Rocket Engines*. 636 pp. Illus. \$13. M. J. Zucrow. Wiley, New York; Chapman and Hall, London, 1958.

These two volumes represent a considerable step forward from the author's earlier book, *The Principles of Jet Propulsion and Gas Turbines* (Wiley, New York, 1948). Zucrow, a noted expert in jet propulsion and a teacher of many years' standing, has recognized that the practices of jet propulsion have moved forward in the past decade and require a more comprehensive treatment. This he has provided.

He has included rocket propulsion in these volumes, correctly categorizing it as a branch of jet propulsion. That rocket propulsion belongs in this category has not always been well understood by other authors, some of whom have tended to separate air-breathing and rocket jet propulsion.

Volume 1 consists of five chapters, of which the first is a review of fundamental principles. This is one of the more valuable chapters, since it allows the reader to go back and "brush up" on fundamental principles without referring to other volumes. Indeed, laudable as the inclusion of this chapter is, one wishes the author had made it even longer, to include, perhaps, more definitions—in particular of words such as *entropy*—and more background on compression and expansion processes in gases.

One of the very important problems

facing the jet engine (and rocket engine) designer is that of heat transfer. Again, a separate chapter on the principles and practices of heat transfer would have been desirable. Indeed, since so much has been written on ballistic equations for space flight, and since other good treatises are available on solid-propellant rocket design, one wishes that the two chapters on ballistics and space flight in volume 2 could have been replaced by one very good chapter on the advanced principles of fluid mechanics and heat transfer.

Nevertheless, the author has vigorously and thoroughly covered (volume 1, chapters 2-5) the general characteristics of propulsion systems, the thermodynamics of compressible fluid flow (inclusion in this chapter of some of the theory and principles of shock tube phenomena would have been interesting), gas flow through nozzles, and flow through diffusers. In these later chapters, a more thorough treatment of rocket and jet-engine nozzle design would have been helpful. Some controversy and some empiricism are manifest in the rocket industry today in connection with the design of the exhaust nozzle. Some designers favor straight cones and other so-called "Prandtl" nozzles. It is true that Zucrow had no thought of catering to the designer (and this is proper), but at least a discussion of the gas flow phenomena in curved nozzles and of the related theory would have been helpful.

In volume 1 Zucrow has included many tables which contribute greatly to an understanding of the theory that he presents. I found his charts of isentropic compressible flow and his tables of conversion factors for dynamic viscosity most helpful.

There is, of necessity, some duplication of material in volumes 1 and 2, but the latter concentrates more on the practical problems of jet engines, covering gas turbine power plant cycles and analysis of ideal cycles (chapter 6); analysis of gas turbine power plants and the turbopropeller engine (chapter 7); and the turbojet engine (chapter 8). These three chapters are easily the most useful I have found in the literature, and section 9 (of chapter 9), on the turbojet engine, which deals with flight performance at the design point, is remarkable for its conciseness and thoroughness.

In chapter 9 the author devotes about 60 pages to the ramjet. This important power plant, somewhat neglected in the literature, warrants all the description and analysis possible. Indeed, the chapter might have been rounded out a bit with a review of actual problems met in the last few years and discussion of the application of ramjets in the field of missile propulsion. There are some interesting variants of the ramjet and tur-

bojet engines called turbo-rockets and ram-rockets. It is true that the author concentrates on fundamental principles as much as possible, but a description, at least, of these power plants would have been desirable. Perhaps this will be included in volume 3.

Perhaps the largest single instance of increase in text material over the earlier book on jet propulsion occurs in chapter 10, "Rocket jet propulsion." Some of the nomenclature and standard expressions—for example, "specific impulse"—reflect the author's earlier work and show that standardization of symbols and terms in the field of rocket propulsion has not yet been achieved. I had to refer continuously to the principal notation at the beginning of the chapter (this notation covers more than two pages and is somewhat labored) in order to understand the equations or at least the terms the author has used in this chapter. The last section of the chapter, on questions of space travel and the multistage rocket, covers only eight pages and might as well have been left out, since, as was stated before, there are more voluminous books available on these subjects. Similarly, the author, in trying to cover as wide a field as possible, has included (section 8, chapter 10) a review of interior ballistics of solid-propellant rocket motors. While this material is useful, it might have been better used for, say, a thoroughly theoretical treatment of rocket combustion, particularly in one of the author's pet fields, combustion instability.

Six tables on enthalpies, rocket propellant properties, and equilibrium constants complete this volume.

In general, despite the minor shortcomings I have noted, these two volumes are a most useful addition to the library of the engineer and designer who wants to get a good understanding of jet propulsion principles without having to refer to a vast number of treatises on the subject.

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Hydrogéologie. Introduction à l'étude des eaux destinées à l'alimentation humaine et à l'industrie. P. Fourmarier. Masson, Paris; Vaillant-Carmanne, Liège, Belgium, ed. 2, 1958. 294 pp. Illus. Paper, F. 3000.

This book is the second edition of a well-known textbook of hydrogeology (or ground-water geology) which was published originally in 1939. Although the present edition contains only ten pages more than the previous edition, an expansion of about 20 percent has been accommodated by use of smaller

type. An improved coverage of water quality and of hydrology of arid regions accounts for much of the expansion. A useful summary of water purification methods has also been added as an appendix.

The book has three major parts. The first covers the general principles of occurrence and movement of ground water. Some of the topics in this section are the hydrologic cycle, porosity, permeability, confined water, unconfined water, and ground-water maps. The second part covers the utilization of water and includes discussions of water quality, diversion of surface water, recovery of ground water, ground-water yield, ground water in areas of permafrost, and ground water in arid regions. The third section contains a discussion of ground water that has unusual thermal or chemical properties.

Many of the recent advances in ground-water geology are not discussed. Topics such as well hydraulics, isotopic composition of water, and geophysical exploration for ground water are either not included or are treated superficially. Some of the terminology also lacks a modern perspective. For example, the term *permeability* is used to describe the variable that many hydrologists prefer to call "hydraulic conductivity." The definition of *permeability* used in the book perpetuates Meinzer's cumbersome expression, which, however, has been dressed in metric units.

Despite these limitations, the book will be valuable to those who desire a general coverage of the topic. A liberal use of diagrams, combined with clear and concise writing, will serve to reduce the language barrier for those whose knowledge of French is limited.

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Introduction to Nuclear Power Costs.

Arnold Rochman. Simmons-Boardman, New York, 1959. 50 pp. \$2.95.

Information on individual nuclear power cost components is presented as a basis for an analytical study of nuclear-power economics. Such a study would be of great interest to the nuclear energy profession if it were based on current information. However, the author uses data derived from the open literature of the period 1946 to 1954, when classification restrictions were still in force. Because of this, information of vital importance to nuclear-power economics, such as the cost of enriching uranium and the cost of processing spent fuel elements, has been excluded. Such an omis-

sion gives one the impression that the study was made 5 years ago and just published. A book so out of date will be of little use in the rapidly expanding field of nuclear-power economics. Because more authoritative and more current treatments of the subject are available, the purchase of this book by libraries and individuals is not recommended.

JAMES A. LANE

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Conference on the Chemistry of Muscular Contraction. Igaku Shoin Ltd.,

Tokyo, Japan, 1958 (distributed in the United States by Charles E. Tuttle, Rutland, Vt.). 140 pp. Illus.

The Committee of Muscle Chemistry of Japan has published in this book the papers presented at the Conference on the Chemistry of Muscular Contraction held in Tokyo in October 1957. Though it was organized on an international level, many leading laboratories in the field were not represented at the conference, very probably for geographical reasons. Thus, the papers do not give a complete picture of the muscle research of today but present, understandably enough, a fairly good cross section of the work of Japanese investigators. In the postwar era a group of very active and enthusiastic Japanese workers made important contributions in the field of muscular contraction. The world-wide recognition that their work has received is reflected in the success of this conference, where 11 of the 24 papers were presented by 22 foreign participants, from five countries.

The character of the great majority of the papers is that of journal articles, complete with experimental materials, methods, and results. The presentation of discussions, written comments, and addenda, following each paper, helps put the data presented in the right perspective. Though the conference was held nearly one and a half years ago, much of the material has not been published elsewhere as yet.

It is beyond the scope of this review to evaluate critically the papers presented. On the other hand, a few highlights may be more appropriate than a mere table of contents. The controversy over whether myosin B dissociates or only changes its shape upon the addition of adenosine triphosphate is resolved in a conciliatory manner by von Hippel, Gellert, and Morales. Myosin B contains three different types of particles; of these, upon the addition of adenosine triphosphate, the largest ones extend, the middle ones dissociate, and the smallest

ones—corresponding to myosin A—do not change. Gergely and Kohler calculate from light-scattering data, with oversimplified theory, the stoichiometry and association constants of myosin A and F actin. Association and dissociation reactions in this system are established beyond any doubt; however, one should bear in mind that synthetic actomyosin and the natural myosin B appear to be quite different in nature. On the other hand, it seems that myosin B is not a simple polymer of myosin A, as the Morales group originally thought, but contains some sort of cement, which can be removed by centrifugation, as von Hippel reports in an addendum.

Kominz, Saad, and Laki give an account of the work on invertebrate tropomyosin and discuss the possible participation of the tropomyosins in the structure of myosin. Tryptic digestion of denatured myosin liberates a tropomyosin-like fragment, thus substantiating Laki's theory that the tropomyosins are building stones of myosin.

Asakura, Hotta, Imai, Ooi, and Osawa, in a very instructive paper, show that the polymerization of actin is similar to the formation of a three-dimensional network. Polymerization proceeds only above a critical protein concentration, which is decreased by increasing divalent cation concentration. The binding of the cations to actin can be demonstrated by electrophoretic and conductivity measurements, but there is no change in the binding properties when actin polymerizes or depolymerizes, or even when it is inactivated by denaturation. Therefore, it is likely that the cation and the actin-to-actin binding sites are at a considerable distance from each other. The authors report in an addendum the striking observation that under certain conditions actin will act as an adenosine triphosphatase, dephosphorylating slowly not only the intrinsically bound, but also the extraneous, adenosine triphosphate.

Tonomura, Matsumiya, Morita, and Kitagawa present double refraction of flow and viscosity data on myosin B solutions, which show that the particles interact strongly, forming an intermolecular entanglement. They also studied the binding of pyrophosphate to myosin B by the equilibrium dialysis technique. The polyanion causes deformation of the myosin particles, and the deformed protein has a much lower affinity for the pyrophosphate anions. Thus, most of the pyrophosphate is liberated upon deformation, but the deformation, once it has been accomplished, is not affected by the removal of the pyrophosphate anions.

The interaction of pyrophosphate with myosin B was studied along different lines by Uchida, Miyazaki, and Nagai. Presumably pyrophosphate binds to the

same sites as adenosine triphosphate, thus acting as a competitive inhibitor of the adenosine triphosphate effects (adenosine triphosphatase, viscosity response, superprecipitation). Magnesium ions seem to mediate the binding of pyrophosphate. Engelhardt, reviewing the work of his laboratory, emphasizes that myosin can combine with substances like Congo red or nucleic acid, reproducing the properties of actomyosin. On the other hand, a myosin-like protein from sperm combines with actin, also giving an actomyosin-like complex.

Considerable attention was given by the authors to the relaxing factors. Ebashi, discoverer of the relaxing effect of microsome preparations, reports on his studies on the effect of surface active agents and phosphatases upon the granules. The adenosine triphosphatase and the relaxing activity can be dissociated, the latter being more labile than the former. The factor proved to be identical with the Kielly-Meyerhof granules. Lorand, Molnar, and Moos also present data on the relaxing system.

In a very interesting paper Natori and Sakai describe their experiments with isolated myofibrils. The dissection under oil permits the myofibrils to remain native, showing the same mechanoelastic properties as the muscle fibers and contracting upon addition of minute amounts of watery solutions. Strikingly, in their effect on contracting ability, "no difference could be found between ATP distilled water and NaCl solution." Watanabe attempts to elucidate the role of sulfhydryl groups in contraction and relaxation of glycerinated fibers from the effect of heavy metals and sulfhydryl reagents upon the mechanical properties of the fibers.

Space does not permit review of the remaining 12 papers. The book presents a valuable source of material for all those who are engaged in investigation of muscular contraction. It is well printed, with numerous graphs and tables, but there are many typographical errors and the English of the Japanese workers sometimes is peculiar, though this does not affect one's understanding of the text.

ELEMER MIHALYI

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New Books

Air Pollution Control. W. L. Faith. Wiley, New York; Chapman & Hall, London, 1959. 266 pp. \$8.50.

Analysis of Straight-Line Data. Forman S. Acton. Wiley, New York; Chapman & Hall, London, 1959. 280 pp. \$9.

Applications of Finite Groups. J. S. Lomont. Academic Press, New York, 1959. 357 pp. \$11.

Chemistry. The elements and their reactions. Eric Hutchinson. Saunders, Philadelphia, Pa., 1959. 758 pp.

Chromatographic Reviews. Progress in chromatography, electrophoresis and related methods. vol. 1. Michael Lederer, Ed. Elsevier, Amsterdam, Netherlands, 1959 (order from Van Nostrand, Princeton, N.J.). 285 pp. \$8.75.

The Determination of Molecular Structure. P. J. Wheatley. Oxford Univ. Press, New York, 1959. 270 pp. \$5.60.

The Earth. Its origin, history and physical condition. Harold Jeffreys. Cambridge Univ. Press, New York, ed. 4, 1959. 436 pp. \$13.50.

East and West in India's Development. Wilfred Malenbaum. National Planning Assoc., Washington, D.C., 1959. 78 pp. \$1.75.

501 Questions and Answers in Anatomy. Stanley D. Mirovianis. Vantage Press, New York, 1959. 332 pp. \$5.

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Reports

Space Charge in Exhaust of Motor Vehicles

Abstract. Exhaust gases are electrically charged, usually positively but sometimes negatively. This charge does not depend on the electric potential of the vehicle. Whether the charge is positive or negative seems to depend on whether water droplets or carbon particles predominate in the exhaust.

It has been shown (1) that clouds of ions whose net charge is sometimes positive and sometimes negative frequently pass overhead at altitudes as low as 10 meters or less. These ion clouds seemed to originate in motor vehicles, particularly, in heavy diesel-powered vehicles. This was confirmed by construction of a space-charge detector in the form of a cylindrical Faraday cage of window screening, 50 cm in diameter and 50 cm long. The cage was grounded. In the center of the cage was placed a polonium button which was connected directly to the input terminal of a Keithley electrometer (model 200A, zero centered) on which the cage rested. When positive (or negative) space charge enters the cage, the potential of the button may be several volts positive (or negative) with respect to ground. This cage was used to test the exhaust gases of the diesel engine of an earth-mover, and these gases were found to be strongly positively charged. The exhaust gases of passenger automobiles were less strongly charged, sometimes positively and sometimes negatively; occasionally they were uncharged. The exhaust gases of one diesel locomotive tested proved to be uncharged. It should be noted that Stimmell, Rogers, Waterfall, and Gunn (2) have shown that, under certain conditions, ionization of the exhaust gases

plays an important role in discharging electricity from an airplane.

In order to explain why the exhaust gases of motor vehicles are charged and to account for the sign of the charge, it was originally assumed that the ions were produced in the combustion chambers of the engine and that the sign of the emitted space charge depended on whether the rubber-tired vehicle was positive or negative with respect to ground. This theory would account for the lack of space charge in the exhaust of a diesel locomotive, since it is well grounded to the rails.

To test this hypothesis further, a bunsen burner was placed about 10 cm from the Faraday cage, and an oscillating fan was used to blow the exhaust gases from the burner into the Faraday cage. When the burner was 5 volts positive with respect to the cage, the electrometer indicated a reading between +1.5 and +2.0 volts when the fan blew toward the cage, showing the presence of pronounced positive space charge. When the burner was 5 volts negative with respect to the cage, the electrometer indicated a reading between -1.0 and -1.5 volts, showing pronounced negative space charge. It is surprising that such a small potential gradient produced such marked charge separation. Apparently most of the negative ions in the flame are electrons whose mobility is high enough to account for the observed charge separation. It might be concluded from this experiment that if the chassis and exhaust pipe of an automobile were positive with respect to ground, the exhaust would contain positive space charge. Similarly, if the exhaust pipe was negative, the space charge should be negative.

The same Keithley electrometer was used to measure the potential of a moving car with respect to ground (contact with ground was obtained by dragging a brass chain). When the car was moving, whether or not the engine was running, the potential of the car was negative. Two cars tested showed the same result, which is in agreement with other tests (3, 4) showing that rubber-tired vehicles generally are at a negative potential with respect to ground. However, when the space charge in the exhaust of these two cars was tested (cars in motion), the space charge in each case, in-

stead of being negative, as anticipated, was positive.

It appears that the emission of space charge by the exhaust pipe of a motor vehicle does not depend on the potential of the vehicle with respect to ground but is caused by contact potential differences between the exhaust pipe and particles in the exhaust such as water droplets or carbon particles. It is well known that wet steam in a locomotive exhaust is positive charged (5), and it is possible that the positive space charge in the exhaust of a motor vehicle is produced by the same mechanism.

To determine the sign of the charge on carbon particles, the following experiment was performed. The exhaust of an automobile was tested for space charge when the engine was "gunned"; generally, the needle of the electrometer would swing from full-scale negative to full-scale positive, the positive deflection gradually decreasing as the engine slowed down. However, when the engine was choked so that black smoke was produced in the exhaust, the electrometer needle swung full-scale negative and stayed there. Several cars tested performed the same way. This indicates that the carbon particles in the exhaust of a motor vehicle are negatively charged.

These results are consistent with the hypothesis that the exhaust of a motor vehicle may be positively or negatively charged, depending on whether water droplets or carbon particles predominate.

When a motor vehicle, especially a heavy truck, is driven along a highway, it may acquire a high negative potential with respect to ground. This is due to the contact potential difference between tires and pavement. Beach (3) has shown that a drag chain under a gasoline truck may be ineffective in discharging the truck due to possible high resistivity of the pavement. It is suggested that the discharge of negative electricity on the truck might be accomplished by the simple expedient of running the engine with choke open at the end of a trip (6).

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5. This was verified by blowing steam from a boiler into the Faraday cage. Only a small puff of steam caused the electrometer needle to go off scale in the positive direction.
6. It is a pleasure to acknowledge the assistance of our shop mechanic, Robert Griggs, in carrying out these experiments. Thanks are also due to Leonard B. Loeb of the University of California for helpful comments on this problem.

8 December 1958

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

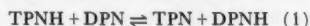
Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" (*Science* 125, 16 (1957)).

Relationship of 3 α -Hydroxysteroid Dehydrogenase to Pyridine Nucleotide Transhydrogenases

Abstract. It appears that the α -hydroxysteroid dehydrogenases are not significant entities in promoting transhydrogenase reactions in animal tissues.

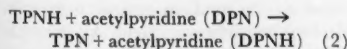
An enzyme catalyzing the oxidation of reduced triphosphopyridine nucleotide (TPNH) by diphosphopyridine nucleotide (DPN) was found originally in extracts of *Pseudomonas fluorescens* (1). This enzyme was purified and was shown to mediate a direct and reversible transfer of hydrogen between di- and triphosphopyridine nucleotides (1-3). The reaction is illustrated in Eq. 1.



The purified enzyme was shown to possess no dehydrogenase activity toward all substrates tested (1). Furthermore, attempts to duplicate transhydrogenase reactions with DPN- and TPN-linked dehydrogenases failed (2). A similar activity has been found in the mitochondrial fraction of many animal tissues (4, 5).

Recently, Talalay and his associates have reported that purified preparations of the soluble fractions of human placenta (6, 7) and rat liver (8, 9) which exhibit DPN- and TPN-linked dehydrogenase activity toward various 3 α -hydroxysteroids can catalyze the above reaction (6-9). 3 α -Hydroxysteroid dehydrogenase linked to both TPN and DPN has been purified from the latter fraction by Tomkins (10) and was employed by Hurlock and Talalay (8, 9) in the studies cited. We should like to clarify the relationship of the steroid dehydrogenases to the pyridine nucleotide transhydrogenase of mitochondria.

We have compared the activities of the TPNH-DPN transhydrogenase (Eq. 1) in the mitochondrial and soluble fractions of rat liver. Activities were determined by following the reduction of the 3-acetylpyridine analog of DPN by TPNH (5). The method is illustrated by Eq. 2.



The data are given in Table 1. At pH 6.5, but not at pH 8.3 (8), a small, but perhaps significant, stimulation of analog reduction by the soluble fraction is obtained in the presence of TPNH. The net reaction is less than 1 percent of the reaction in mitochondria and does not appear to be influenced by the presence of androsterone. The relatively high rate of endogenous acetylpyridine (DPN) reduction in the unmodified rat liver soluble fraction appears to be due to the presence of DPN-linked dehydrogenase and endogenous substrates, particularly

since the activities increase at higher pH values. The specific activity of the 20-fold purified enzyme of Hurlock and Talalay (8) may be calculated from their data to be 1.1 μmole per minute per milligram of protein, and therefore the activity of their enzyme in the unmodified rat liver soluble fraction would be of the order of 0.05 μmole per minute per milligram of protein, or about 0.05 percent of the specific activity of the reaction as it occurs in mitochondria. It is of interest that the calculated specific activity of the TPNH-DPN transhydrogenase linked to androsterone in the rat liver soluble fraction is quite insufficient to account for the small net rate of reaction 2 we have observed in this fraction at pH 6.5, even if the difference in the rate of reaction between DPN and its acetylpyridine analog, in the case of the placental enzyme (7), is taken into account.

We have pointed out elsewhere (5) that the purified beef heart transhydrogenase is not affected by estradiol-17 β . Similarly, we have now found that the partially purified rat liver mitochondrial enzyme will not respond to additions of either androsterone or androstane-3,17-dione. Significant differences exist in the K_m and rates of reaction with the various pyridine nucleotides between the mitochondrial enzymes we have described (5) and the steroid-linked transhydrogenase reactions described by Talalay and his associates (7).

It is clear from the above that the enzyme from mitochondria is a different entity from the soluble steroid dehydrogenase, as Talalay and associates have stated (9). There is no evidence

at the present time to suggest that steroids are involved in the transhydrogenase reactions of mitochondria, although the possibility that the enzyme has a cofactor always exists. As Talalay has suggested (6-9), all steroid dehydrogenases might exhibit transhydrogenase activity, but it must be emphasized that this does not imply that all transhydrogenases are steroid dehydrogenases. In view of the extraordinarily great difference in transhydrogenase activity between the mitochondrial system and steroid-linked dehydrogenases, we would question their statement (9) that the latter enzymes function efficiently in the transhydrogenase reaction. Even if the low absolute activity of the transhydrogenase reaction catalyzed by hydroxysteroids is ignored, the fact that the activity of this reaction, as catalyzed by the placental enzyme, is about one-tenth the activity of the dehydrogenase reaction (7) casts doubt on the significance of these enzymes in the transhydrogenase reaction in the cell. It is difficult to see how such low activities could be of importance in regulating the flow of electrons between the two forms of the pyridine coenzymes, even in the soluble portion of the cell.

The fact that a certain enzyme can be manipulated to catalyze a given reaction does not imply that this is a physiological role for the catalyst. Triosephosphate dehydrogenase will catalyze the oxidation of acetaldehyde; this, however, does not impute a physiological role for this enzyme in the oxidation of acetaldehyde (11). Under conditions of high lactate concentration generated by TPNH, pyruvate, and concentrated lactic dehy-

Table 1. Reduction of the 3-acetylpyridine analog of DPN by TPNH in rat liver fractions. All cuvettes contained 3 μmole of KCN, 300 μmole of potassium phosphate buffer (pH 6.5) or 60 μmole of Tris \cdot HCl (pH 8.3), and 0.6 μmole of 3-acetylpyridine (DPN) in a final volume of 3 ml. TPNH (0.4 μmole) and androsterone [2 μg in 0.01 ml of dioxane (8)] were added as indicated. The mitochondrial fraction was a suspension representing 250 mg of fresh liver per milliliter in 0.5 percent digitonin (5); 0.05 ml of suspension containing 0.4 mg of protein was added to the appropriate cuvettes. The soluble fraction was the supernatant of a rat liver homogenate centrifuged 2 hours at 105,000 g; 0.2 ml of this fraction, containing 2.4 mg of protein, was added to the appropriate cuvettes. The reactions were followed at 375 $m\mu$ (5), and the values were calculated assuming $E_{m\mu} = 5.1$ for all changes in optical density. All values for cuvettes containing TPNH have been corrected for small changes in optical density in control cuvettes containing TPNH but no analog. All values have been calculated from the slope of the initial rate of reaction.

Additions	Fraction	Acetylpyridine (DPNH) formed ($\mu\text{mole}/\text{min}$ per milligram of protein)	
		pH 6.5	pH 8.3
None	Mitochondria	2.2	1.5
TPNH	Mitochondria	114	66.5
None	Mitochondria	2.2	2.0
TPNH + androsterone	Mitochondria	121	67.9
None	Soluble	1.5	5.5
TPNH	Soluble	2.4	5.3
Androsterone	Soluble	1.5	5.3
TPNH + androsterone	Soluble	2.2	5.7

drogenase (0.8 mg/ml), Holzer and Schneider (12) were able to demonstrate a small reduction of DPN upon the addition of unusually large amounts of this pyridine nucleotide (12 mg/ml). Although a similar reaction proceeded with somewhat greater facility in the case of glutamic dehydrogenase (12), it is unnecessary to add that these observations do not establish physiological roles for either enzyme in pyridine nucleotide transhydrogenase reactions.

We suggest that the term *pyridine nucleotide transhydrogenase* be reserved for enzymes exhibiting these activities as quantitatively primary functions, and which, by virtue of concentration in unmodified tissue fractions or high purification, possess a reasonably high specific activity (13).

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Direct Experimental Observation of Cells in Phenomic Lag

Abstract. By employing cells mutating at a very high spontaneous rate and a grid plate containing a medium totally selective against mutant cells, direct microscopic observation was made of mutant cells of recent origin passing through a limited number of phenomic lag divisions.

The concept that cells immediately following mutation are phenotypically normal and require several generations for mutant phenotype expression has

Table 1. Number of microcolonies of various terminal sizes on lactate grid plates. Cells of strain 14940 were plated from shaken cultures growing in lactate nutrient broth at 35°C.

No. of cells in initial configuration*	No. of cells in final configuration*																Total microcolonies	Total macrocolonies
	1	2	3	4	5	6	7	8	9	10	11-12	13-14	15-16	17-20				
1	55	91	87	65	45	14	19	10	3	1	9	1	3	5	408	160		
2		68	22	26	32	22	20	15	16	13	16	11	7	9	277	699		
3			4	2	3	4	3	0	5	3	5	2	2	1	34	229		
4				0	0	0	1	1	0	0	1	1	0	0	4	76		
5					0	0	0	0	0	1	0	0	0	0	1	25		
6						0	0	0	0	0	0	1	0	0	1	16		
7							0	0	0	0	0	0	0	0	0	2		
Total															725	1207		

* Buds scored as cells.

been invoked to interpret discrepancies in mutation rates estimated by various methods (1) and to interpret the effect of intermediate cultivation after exposure to mutagens on the number of mutants expressed (2). Ryan (3) reviewed the evidence for phenomic lag and concluded that it was not compelling.

The likelihood of direct observation of a newborn mutant in phenomic lag is unreasonably small when the mutation rate is low. When the rate is high (for example, 10 to 40 percent; as in the cytoplasmic mutation to respiration deficiency in some yeast strains) the direct observation of phenomic lag becomes possible on a medium totally selective against the mutant. Under these conditions one predicts that normal cells should form colonies (complete development), old mutant cells or dead cells should fail to divide (no development), but mutant cells of recent origin should exhibit only one or a few divisions (limited development), if phenomic lag does in fact occur.

Intermittent observation of the development of many individual cells on an agar surface may be made if each cell can be relocated on a grid. A convenient grid plate may be constructed as follows. Ten razor blades are clamped together with the edges aligned on a plane surface. The blade edges are used to cross stamp the dry agar surface of a 2-day-old plate lightly, yielding a grid of squares approximately 0.1 mm on edge. One drop of a cell suspension (about 1×10^4 cells/ml) is placed directly on the grid. If the agar is dry the drop is rapidly absorbed, and microscopic observation may be begun almost immediately. The mechanical stage is modified to accommodate a petri dish, the corner of the grid is located under low and then high power and, as the grid is scanned, each cell or configuration (singlet, doublet, triplet, and so on) is drawn on a paper facsimile of the grid. At timed intervals the grid is scanned and the number of cells in each configuration is again recorded. Intermittent microscopic observation may be made of the open plate for 48 hours

without visible interference from airborne contaminants. The tendency of growth to become confluent interferes with longer periods of observation.

Two plating media have been employed. One, a glucose nutrient agar, allows both respiration-deficient and respiration-sufficient cells to form colonies. The other, a lactate, nutrient agar allows only respiration-sufficient cells to form colonies (4). When a respiration-deficient clonal isolate of strain 14940 (5) growing in exponential phase in glucose nutrient broth was transferred to glucose grid plates, essentially all cells or configurations developed to form colonies. A low frequency (less than 1 percent) failed to produce a single bud and were considered dead cells. When aliquots of the same culture were studied on lactate grid plates, not a single new bud was formed in more than 1000 configurations. To test whether the respiration-deficient cells had died on the lactate agar, a doughnut-shaped ring of filter paper impregnated with glucose was placed on the agar surface surrounding the grid. After some lag, essentially all configurations budded on the plates to which glucose had been added. These cells were therefore still viable. Although previous observations (4) had indicated that respiration-deficient cells were incapable of forming macrocolonies on lactate agar, the observation of the complete failure to form new buds on the lactate grid plate is more critical evidence for the totally selective character of the medium against such cells. It does not, however, yield any information concerning the ability of respiration-deficient cells recently arisen from respiration-sufficient cells to produce buds in the selective medium.

Strain 14940 exhibits a high spontaneous mutation rate to respiration deficiency when it is growing exponentially in lactate nutrient broth at 35°C (about 40 percent). When samples of this culture were transferred to glucose grid plates, essentially all configurations (except 1 percent inviable) developed to microcolonies within 24 hours and to macrocolonies by 48 hours. On lactate grids however, many configurations (30.9

percent) developed only to a limited extent, as is shown in Table 1. The terminal microcolonies formed were shown to be mutant and viable. When glucose was added to lactate grids after 24 hours, growth was resumed. On control grids which were not supplemented by glucose, only a few microcolonies produced additional buds between 24 and 48 hours. Replating cells from microcolonies 24 hours after supplementation by glucose yielded only mutant colonies by tetrazolium overlay (6). Under different conditions or with other strains where the mutation rate was lower (about 1 to 2 percent), a parallel decrease in the frequency of colonies exhibiting limited development was observed.

The prediction of limited development for a considerable number of cells is thus fulfilled only with a strain showing a high mutation rate on a medium totally selective against the mutant. Further development is produced by delayed supplementation of the medium with a nitrilite which sustains mutant growth, indicating that development is not limited by death.

These observations are interpreted as the direct experimental observation of phenomic lag (7). When a respiration-sufficient cell produces a respiration-deficient bud, the latter still retains residual respiratory enzyme capacity and can proceed through a number of divisions until its respiratory capacity is diluted to the level of the respiration-deficient cell. Since the medium is totally selective against cells which lack respiratory ability, mutant cell division ceases when the phenomic lag is completed.

If one assumes essentially equal partition of the residual respiratory capacity during divisions of a newborn respiration-deficient mutant, no more than four or five phenomic lag generations should be possible. The grid plate experiments indicate that no configurations exhibiting limited development reached a terminal size compatible with more than five phenomic lag generations. The configurations exhibiting fewer phenomic lag generations probably arose from mutations which occurred one or more generations before plating.

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26 February 1959

Interaction of Curare and Related Substances with Acetylcholine Receptor-Like Protein

Abstract. Existence of a receptor protein for acetylcholine has been postulated, and the hypothesis has been supported by experiments in intact cells. A protein from electric tissue has now been obtained in solution; there is striking parallelism between the ability of this protein to bind acetylcholine analogs and the effects of such analogs on electrical manifestations of intact electroplax.

The effect of acetylcholine in conduction and transmission of nerve impulses has always been attributed to its action upon a "receptor." Experimental evidence for the existence of a receptor has been obtained in studies with isolated electroplax of *Electrophorus electricus* (electric eel) (1). Recently Chagas and his coworkers have attempted to isolate the receptor (2). Their approach was based on the finding that radioactive triethiodide of gallamine (TRIEG)—a curare-like substance—is bound to a component (or components) present in an extract of the electric tissue of electric eel, a tissue undoubtedly rich in the receptor. Such complexes appeared to exhibit a fair degree of specificity with regard to competition between TRIEG and other substances known to have an affinity for the receptor (2). However, the fact that the formation of these complexes was reduced even in very dilute salt (0.02M) raises the question of whether the macromolecule responsible for the observed binding was indeed the receptor, inasmuch as curarization of intact electroplax is readily accomplished even in 0.18M salt (3). Moreover, the competition of various substances with curare that is observed on intact electroplax (3) differs in several respects from Chagas' results as to their competitive action in solution. Further exploration of this problem therefore appeared desirable.

The procedure followed (4) differs from that used previously in two important aspects. First, the tissue extract was subjected to ammonium sulfate fractionation and the resulting protein fractions were examined for their ability to bind curare and related substances. Since curare has two cationic nitrogen groups, it may react unspecifically with a number of macromolecules through Coulombic and van der Waals forces. Such binding was found to occur with

nucleic acid and chondroitin sulfuric acid—components present to some extent in electric tissue extracts but eliminated by fractionation. Second, our method of studying the interaction is that of equilibrium dialysis (5) under controlled conditions of pH and ionic strength. Data thus obtained are less ambiguous than those from experiments in which binding has been determined after prolonged dialysis against large volumes of distilled water (2). All experiments were performed at 0°C and pH 7.5; it was assumed that equilibrium had been established when dialyze analyses on successive days gave concentrations which checked to within 5 percent. Concentrations were determined by ultraviolet absorption. Calculations of the amount of material bound were based on the concentration of the outside solution of the particular substance when it was dialyzed against the protein as compared with the concentration when it was dialyzed against buffer. Analyses of inside solutions at equilibrium gave results which agreed well with those calculated by the indirect method.

The results are shown in Fig. 1. The following features appear to be pertinent. (i) There is a striking qualitative agreement between the degree of binding of curare and related substances in solution and the affinity of these compounds for the receptor, as measured by their effects on the electrical activity of intact electroplax (3). Thus, with respect to action on intact cell and the degree of binding in solution, these compounds have the following relationship, in descending order of effectiveness and binding ability: curare, dimethyl curare, prostigmine, eserine. In both types of studies, dodecylpyridinium proved to be

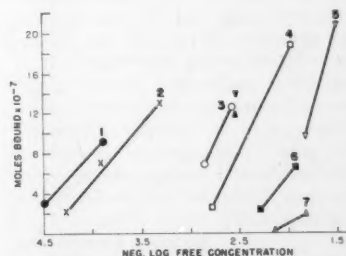


Fig. 1. Binding of curare (*d*-tubocurarine) and various related compounds to proteins obtained by ammonium sulfate fractionation of electric tissue. Protein concentration = 15 mg/ml, pH 7.5, 0°C. Curves 1 and 2, $\mu = 0.02$; curves 3–7, $\mu = 0.1$; curve 1, curare; curve 2, dimethyl curare; curve 3, curare; curve 4, dodecylpyridinium chloride; curve 5, prostigmine sulfate; curve 6, eserine salicylate; curve 7, methylpyridinium iodide. Curve 3 also shows data for binding of curare (0.004M) in the presence of (▼) prostigmine (0.05M) and (▲) decamethonium (0.02M).

much more effective than the methylpyridinium compound. It is to be noted that bovine serum albumin at a comparable concentration failed to bind any of these compounds, with the exception of dodecylpyridinium. (ii) The binding of curare, although salt-sensitive (compare curves 1 and 3), still occurred at a relatively high ionic strength ($\mu=0.1$). As could be predicted from these results, a decrease in the ionic strength of the medium surrounding the electrophoresis resulted in a marked enhancement of the effect of curare (6). (iii) Addition of decamethonium and prostigmine did not result in the displacement of curare from the complex in solution. In agreement with these observations, it was found that these compounds, which depolarize the electrophoresis in low concentrations, are without effect on electrophoresis blocked by curare even when they are applied in concentrations several times as high as that of the curare (3).

The curare-binding component has been purified to a considerable extent by further fractionation of the extract with ammonium sulfate. A protein fraction has been obtained which, at a concentration of 0.5 mg/ml ($\mu=0.1$; pH, 7.5), gives a precipitate with curare (2 mg/ml). Under similar conditions, chondroitin sulfate (3 mg/ml), deoxyribonucleic acid (2 mg/ml), and proteins of other fractions (15 mg/ml) fail to precipitate with curare. The precipitate, which contains about 50 percent of the proteins in this fraction, can be further fractionated by prolonged dialysis against 0.1 M phosphate, pH 7.5. Part of the precipitate (about 20 percent) goes into solution, the remainder being solubilized by dialysis at pH 9. It is suggested that the latter material, which has a protein ultraviolet spectrum, may form highly specific complexes with curare and related compounds and thus has receptor-like properties. In line with the proposals of Nachmansohn and Wilson (7), it will be of considerable interest to determine whether those neurotropic agents considered to be "receptor activators" can induce configurational changes in this protein and whether the so-called "receptor inhibitors" are ineffective in this respect (8).

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8. I wish to express my gratitude to Dr. D. Nachmansohn for his continuous encouragement and interest in this work.

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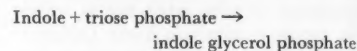
Enzymatic Activity of a Genetically Altered Tryptophan Synthetase in *Neurospora crassa*

Abstract. Partially purified preparations of certain tryptophan-requiring mutants of *Neurospora crassa*, which contain a protein (CRM) antigenically related to wild-type tryptophan synthetase, possess indole glycerol phosphate-synthesizing activity. This activity can be inhibited by anti-CRM sera. It is suggested that CRM in such mutants represents a damaged tryptophan synthetase lacking the capacity to react with L-serine.

A number of microbial mutants unable to form L-tryptophan from indole and L-serine have been described (1-3). Crude extracts of such tryptophan-requiring (td) mutants of *Neurospora crassa* and *Escherichia coli* contain no tryptophan synthetase activity, but in most instances the presence of large quantities of a protein (CRM) antigenically related to tryptophan synthetase can be demonstrated (2; 4-6). Studies with *E. coli* (2, 6) have shown that CRM-containing preparations from certain tryptophan-requiring mutants will catalyze the conversion of indole glycerol phosphate to indole plus triose phos-

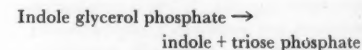
phate. These results indicate that CRM in *E. coli* appears to be functionally as well as structurally related to tryptophan synthetase. Experiments to date, in which both the *Neurospora* and the *E. coli* systems were employed (5-9), seem to support the view that the CRM proteins may represent genetically altered tryptophan synthetase molecules.

The present report (10), based on antienzyme studies with the *Neurospora* system, demonstrates that the reaction:



which is catalyzed by certain CRM-containing preparations, can be specifically inhibited by anti-CRM serum. This anti-serum also inhibits the wild-type tryptophan synthetase activity (5).

Strain td₂ (1), a tryptophan-requiring mutant that accumulates indole and indole glycerol in culture filtrates (8), was used for most of these experiments, although preparations from several other strains appear, on preliminary screening, to give similar results. Partially purified td₂-CRM preparations, known to catalyze the reaction (11)



are able to convert indole and triose phosphate to indole glycerol phosphate. Maximum activity occurs only in the presence of fructose diphosphate, aldolase, and pyridoxal phosphate (12). The methods for determining indole disappearance and indole glycerol phosphate formation have been described (2). Although some indole glycerol phosphate is synthesized, it is apparent that considerably more indole disappears from the reaction mixture than can be accounted for by the indole glycerol phosphate formed. In addition, the rates of

Table 1. Effect of anti-CRM serum on the enzymatic activity of CRM. A constant number of td₂-CRM (5) units was added to each of several tubes containing increasing amounts of anti-t₂-CRM serum. The tubes were stored in an ice bath for 5 minutes, followed by the addition of the substrate mixture: (7.5 μmole of indole, 10 μmole of fructose diphosphate, 40 μg of pyridoxal phosphate, 2 × 10⁻³ M glutathione, 0.2 ml of crude *Neurospora* aldolase, and 0.1 M phosphate buffer, pH 7.8). The final volume per tube was 4.4 ml. Samples were incubated at 37°C for 1 hour. The reaction was stopped with 0.2 ml of 5 percent sodium hydroxide. Indole was extracted with 15 ml of toluene, and aliquots were assayed by the *p*-dimethyl aminobenzaldehyde method (2).

Antibody	Anti-CRM (unit)	CRM (unit)	Indole disappearing in reaction mixture (μmole)
Anti-t ₂ -CRM	45	77.7	0.40
Anti-t ₂ -CRM	60	77.7	0.02
Anti-t ₂ -CRM	120	77.7	0.0
td ₂ -absorbed anti-t ₂ -CRM	19	77.7	0.55
td ₂ -absorbed anti-t ₂ -CRM	38	77.7	0.45
td ₂ -absorbed anti-t ₂ -CRM	76	77.7	0.0
Anti-t ₂	Equivalent volume	77.7	0.75
Nonimmune serum	Equivalent volume	77.7	0.75

indole uptake and indole glycerol phosphate formation differ significantly.

Results similar to this have been observed in experiments on indole uptake with mycelial pads of strain td_2 (13), suggesting that several products may be formed from indole during the course of the reaction. It should be emphasized however, that close agreement is obtained between indole uptake and the number of units of CRM in the extract, whether different aliquots of the same preparation or different preparations are compared. Furthermore, extracts of mutant strain td_1 , a mutant which forms neither tryptophan synthetase nor CRM (1, 4, 5, 14), exhibit no "indole uptake" activity.

Rabbit anti- td_2 CRM sera (5) were tested for their ability to inhibit the indole reaction catalyzed by td_2 -CRM-containing preparations. It was found that unabsorbed anti- td_2 CRM serum, and anti- td_2 CRM serum absorbed with extracts of strain td_1 , a mutant which lacks both tryptophan synthetase and CRM (5) completely neutralize enzyme activity. As is shown in Table 1, anti- td_1 serum (5) has no inhibitory effect.

These results seem to support the proposal that the CRM protein in *Neurospora* mutant td_2 is the protein responsible for catalyzing one or more reactions involving indole. It would appear most likely that td_2 -CRM represents one of a variety of possible types of genetically altered tryptophan synthetase molecules. In this case an alteration in protein structure seems to have eliminated the reactivity of the protein with L-serine, albeit an indole-combining site is still retained. It is well known that specific suppressor mutations are capable of partially restoring tryptophan synthetase activity in certain CRM-forming td mutants of *Neurospora* (1). Perhaps one mechanism of action of such suppressor genes involves the conversion of a CRM protein to active tryptophan synthetase by reactivating an inactive catalytic site on the CRM protein (7, 15).

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11 December 1958

Fat Changes during Adolescence

Abstract. Lower thoracic fat, as measured on serial chest plates of 259 children in Ohio, increased in girls, between ages 6.5 and 14.5 years and, in boys, between ages 6.5 and 11.5 years. No evidence for a marked loss of "baby" fat in adolescence or for "waves" of fattening around the time of puberty was found.

The literature on human growth refers to a number of changes in body fat during adolescence, including a loss in "baby" fat that is popularly believed to occur and the existence of several waves of fattening that supposedly occur either before or after the spurt in stature (1). However, currently available data are insufficient to confirm these generalizations, and the still-limited findings are contradictory.

In the present study, outer fat was investigated on the lower thorax (2) at the level of the tenth rib, in 259 regular participants in the Fels longitudinal program, by means of serial posteroanterior chest radiographs. Sex-specific samples ranged from 16 to 93, the age range was 6.5 to 17.5 years, and the average sample for each age group was 124. In the treatment of the data, median values were used because of the marked skewness of all 24 distributions.

As is shown in Fig. 1, there was a parallel increase in fat on the lower thorax in both sexes from the 6th through the 11th year, the median values for the girls being about 1 mm (or 40 percent) above those for the boys. Thereafter, fat on the lower thorax continued to increase in the girls, reaching a thickness of 8 to 9 mm by the 14th year, while in the boys it stabilized at about 4.5 mm between the 11th and the 17th years. No loss of "baby" fat was evident for the girls in this cross-sectional analysis, and the tiny (0.2-mm) decrease in the median values for the boys between 11 and 13 years was not statistically significant.

Further analysis of the data, on a longitudinal basis and on the basis of physiological events rather than chronological

age, yielded similar results. For the girls, rearrangement of the fat measurements relative to the individual age at menarche or to the year of the maximum spurt in stature confirmed the observation that there is a fairly uniform increase in fat from childhood on. In the boys, the maximum accumulation of fat on the lower thorax generally preceded the year of the spurt in stature, and there was a suggestion that there is a small decrease about 2 years after this event.

The lack of data that would indicate a period of fat loss, or of "waves" of fattening in girls, was in agreement with earlier findings on the same population sample (3) and with data on fat in the calves of girls in Boston (4). The trends in fat on the lower thorax of boys in Ohio, while in general agreement with trends in fat at other sites in the same group (3), were quite different from trends in fat in the calves of Boston boys (4) and different from trends found by pinch-caliper measurements of boys in California (1). While increase in fat in the boys was noted in all three studies, there was no agreement about when it began, when it terminated, when there was a fat loss, or when there was a steady-state leveling off.

These discrepancies may be due to differences in the sites selected, since fat may increase on one part of the body and decrease simultaneously on another part during growth (5). Alternatively, the divergent trends apparently exhibited by California, Ohio, and Massachu-

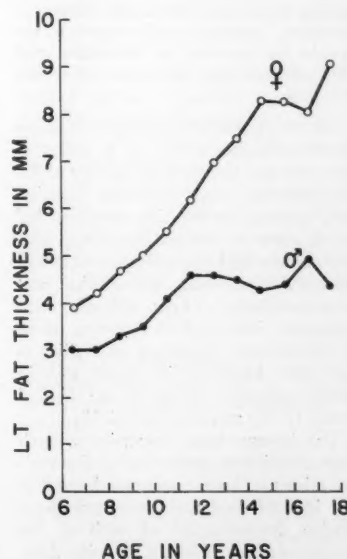


Fig. 1. Continuous increase in lower thoracic fat in girls and parallel increase in boys, terminating at 11.5 years. By 14.5 years the adult female/male fat ratio of 180 percent (2) has been attained.

setts boys may reflect true differences in the populations sampled. The simplest explanation that fits our data is that of a steady increase in outer fat in both sexes, with a temporary interruption in the male during the period of steroid hormone differentiation.

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Dissolution of Interlayers from Intergradient Soil Clays after Preheating at 400°C

Abstract. Dehydroxylated interlayers have been removed from chlorite-vermiculite-montmorillonite intergrades by boiling the preheated sample in 0.5N NaOH for 2.5 minutes. Elements extracted can be conveniently analyzed spectrophotometrically. A convenient method of estimating the amount of elements present in interlayer positions and preparing the sample for analysis for expanding and nonexpanding mineral components is thus provided.

An intergradient chlorite-vermiculite-montmorillonite is one of a series of layer silicates having heat stability of the 14-A spacing, cation exchange capacity, and specific surface intermediate between those of the nonexpanding mineral chlorite and the two expandable and collapsible minerals, vermiculite and montmorillonite. Layer silicates with properties intergradient between those of chlorite and expanding layer silicates have been identified in several soils in widely separated areas of the United States (1, 2) and in England (3).

The intergradient properties of such clays, relative to properties of the typical minerals, have confounded qualitative identification and prevented quantitative determination of each of the component clay minerals in soils. Also, the aluminum generally present in intergradient clays of soils actively affects chemical reactions, particularly those of soil acidity and liming, phosphorus fixation, and potassium fixation.

It has been found that the elements which give the intergradient properties can be dissolved from between the layers after dehydroxylation of the interlayers of preheating the dry, loose, hydrogen-saturated clay at 400°C for 4 hours. The dissolution is accomplished by boiling the preheated clay sample in 0.5N NaOH (at a ratio of 40 ml of NaOH to 40 mg of clay) for 2½ minutes, which is the differential dissolution procedure of Hashimoto and Jackson (4). The Al and Si dissolved by the treatment are immediately determined colorimetrically (5). The iron oxide precipitated during the NaOH treatment is removed by the dithionite-citrate-bicarbonate method (6; 7, p. 57). Removal of allophane from the clay by the same dissolution procedure applied to a sample with only 110°C preheating (4) permits calculation of the Al that is made soluble by the 400°C preheating.

Elements dissolved from the samples preheated at 110° and 300°C had a small effect on the intergradient properties, as is shown by some increase in intensity of the 18-A peak (Fig. 1) at the expense of the 14-A peak. However, the NaOH treatment of a different sample preheated at 400°C resulted in a marked increase in the amount of material which expanded to 18-A with Mg saturation and glycerol solvation and in the amount which collapsed to 10-A on K saturation and heating at 300°C in x-ray diffraction preparations (7, p. 184).

A small amount (about 0.6 percent) more alumina removed after preheating at 400°C than after preheating at 300°C is responsible for the marked difference in the 14-to-10-A collapse in the x-ray preparation (Fig. 1). This aluminous interlayer which impaired 14-to-10-A collapse on heating at 300°C is stable to higher temperatures than is free $\text{Al}(\text{OH})_3$ as gibbsite, but to lower temperatures than complete $\text{Al}(\text{OH})_3$ interlayers in chlorite. This is interpreted to indicate the presence in the intergrade of islands of positively charged hydroxy aluminum which bridge between potentially collapsible (and expandable) silicate layers. The percentage of alumina removed, when compared with that in complete gibbsite-like interlayers in aluminous chlorite, indicates that the islands in the intergrade are of limited extent.

Preheating the clay at 500°C destroyed the kaolinite, as is shown by the loss of the 7.2- and 3.57-A x-ray diffraction peaks (Fig. 1). The possibility that the 7.2-A peak is indicative of chlorite is ruled out by the absence of 14- and 4.6-4.8-A peaks (8) in the 400°C/K/300°C sample (Fig. 1) and by the fact that soil chlorites which lose their 7-A peak and reinforce their 14-A peak on

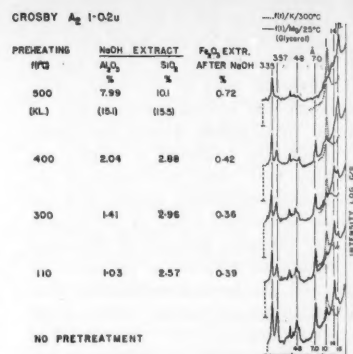


Fig. 1. Elements extracted and x-ray diffraction curves before and after NaOH extraction of the 1-0.2 μ fraction of Crosby soil, A₂ horizon, with various temperatures of preheating, f(t°C), K or Mg saturation, and glycerol solvation followed by 25° or 300°C heating of slides for x-ray diffraction.

500°C preheating are not appreciably dissolved by subsequent NaOH boiling (9). The differences (Fig. 1) between the alumina and silica extracted by the same NaOH extraction procedure (4) after the 400° and 500°C preheatings allocate to 15.1 and 15.5 percent kaolinite based on the two elements, respectively. Considerable increase in intensity of the 10-A peak (Fig. 1, 500°C/K/300°C versus 400°C/K/300°C) may be due to increase in ordering produced by the removal of a small amount more interlayer aluminum after preheating at 500°C than was removed after preheating at 400°C. Thus the alumina allocated to kaolinite may be slightly high despite the agreement between the allocations to kaolinite of alumina and silica. A little excess silica must be allocated to a small amount of nontronite destroyed, as is shown by the small increase in iron oxides released by 500°C preheating over those released by 400°C preheating; this would allow for a small amount more alumina from the intergrade made soluble by the 500°C preheating.

The dehydroxylation-NaOH method of dissolving interlayers from layer silicate intergrades was found to be more effective, more rapid, and far more convenient for analysis of the elements extracted than the citrate (2) or fluoride (10) methods previously available. This method was tested on intergradient clays from Tatum soil (Virginia) and Cookeville soil (Kentucky) and was found to give results comparable to the above results with the Crosby soil clay (11).

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28 January 1959

Color Reaction for Certain

Amino Acids, Amines, and Proteins

Abstract. Proteins, certain amino acids, and amines undergo a potentially useful color reaction. The reaction involves the apparent formation of pyrroles when the compounds are allowed to react with acetylacetone. The pyrroles yield colored complexes on coupling with *p*-dimethylaminobenzaldehyde. This report describes the specificity and possible uses of this reaction in colorimetric measurements and in paper chromatographic detection of these compounds.

In experiments measuring hexosamine by the Elson-Morgan reaction (1) in various crude extracts, it was found that substitution of acetylacetone for acetylacetone gave values much higher than expected on the basis of the indole HCl (2) or standard Elson-Morgan (1) methods. Preliminary results (3) indicated that this was not due to a greater color yield per unit of hexosamine, for, with a standard glucosamine sample, the use of acetylacetone resulted in less color (about one-half) than use of acetylacetone. This suggested the possibility that the acetylacetone reacted with a wide variety of amino compounds to form pyrroles (4) which were subsequently available for coupling with *p*-dimethylaminobenzaldehyde.

A study of the specificity (3) toward a number of compounds was undertaken. Amino acids, sugars, organic acids, purines, pyrimidines, amines (primary, secondary, and tertiary), and many miscellaneous compounds were

tested. None of the sugars glucose, galactose, fucose, and rhamnose, at concentrations as high as 10 mg/ml, gave appreciable color. Citric acid at the same level gave no color. The following purines, pyrimidines, amino acids, amines, and miscellaneous compounds, at 0.5 to 2 mg/ml levels (or saturation for those of low solubility), gave little or no color: xanthine, allantoin, adenine, creatine, guanine, hemin, uracil, urea, ribonucleic acid, triethanolamine, choline chloride, diphenylamine, aspartic acid, leucine, phenylalanine, glutamic acid, proline, cystine, methionine, isoleucine, valine, tyrosine, and tryptophan. In Table 1 are given the relative light absorptions at 530 mμ, of the compounds reacting positively. The color from compounds giving positive results was red, with the exception of aniline, which gave a very intense yellow color. The following proteins in concentrations as low as 1 mg/ml also gave fairly intense red complexes: gelatin, egg albumin, lysozyme, and gastric mucin. It is evident that the sensitivity varied widely, being particularly high with certain amino acids, amines, and proteins.

The positive reaction found for NH₄OH (Table 1) is quite interesting and is included to indicate that precautions must be taken to exclude it; exclusion is also necessary when Ninhydrin is used (5).

The conclusion that the color developed with the amino acids, amines, and proteins was due to a coupling of *p*-dimethylaminobenzaldehyde with some product (perhaps pyrrole) formed by a reaction with acetylacetone (but not with acetylacetone) is supported by the following control determinations. Direct treatment of the compounds with *p*-dimethylaminobenzaldehyde without prior acetylacetone treatment gave no color other than a light violet with gastric mucin and a very slight yellow with tryptophan, citrulline, and urea. Treatment with acetylacetone without heat gave similar results. Treatment with *p*-dimethylaminobenzaldehyde preceded by a heating period in the presence of Na₂CO₃ but without acetylacetone also gave the same results. Use of the standard Elson-Morgan method with acetylacetone on the same compounds yielded only the typical red color with glucosamine and a slight yellow with tryptophan, citrulline, and urea.

The potential usefulness of this reaction stems from the following. First, the absorption spectra of representative materials—egg albumin, gastric mucin, lysozyme, lysine, arginine, glycine, tryptamine, histamine, and ethanolamine—all show peaks at 530 mμ. The light absorption at this wavelength is linear with concentration for the amino acids below 0.1 to 0.2 mg/ml, for the proteins

Table 1. Relative color intensities of compounds reacting positively in the acetylacetone test.

Compound	Optical density/mg at 530 mμ
Alanine	0.374
Histidine	0.406
Arginine	0.720
Lysine	1.10
Threonine	0.865
Glycine	2.00
Serine	0.285
Ornithine	1.70
Tyramine	1.60
Citrulline	0.595
NH ₄ OH	0.950
Ethanolamine	1.70
Ethylenediamine	1.90
Ethylamine	1.90
Tryptamine	1.70
Histamine	1.70
Glucosamine	1.70

below 1 to 2 mg/ml, and for the amines below 0.05 to 0.1 mg/ml.

Second, the method may be useful in the measurement of protein. A comparison of this method with the Biuret method (6) in the measurement of protein is shown in Table 2. It is evident that the variation between individual proteins with the acetylacetone method is no greater than it is with the Biuret method and that it would be much less than with methods based on the measurement of a single amino acid (or types of amino acids such as those with 280 mμ absorption, or reactions specific for tryptophan or tyrosine). The sensitivity of the acetylacetone method is about 10 times greater than that of the Biuret method, as is shown in Table 2. The sensitivity is, however, less than that with the Folin phenol method (7) by a factor of 5 to 10.

Third, the method may be useful as a dip reagent in paper chromatography. The most suitable method tried (8) resulted in pink to lavender colors with four lambda spots on filter paper of the

Table 2. Comparison of the specificity and sensitivity of the biuret and acetylacetone methods in the measurement of proteins.

Protein	Optical density/mg at 530 mμ	
	Biuret	Acetylacetone
Gelatin	0.032	0.375
Egg albumin	0.036	0.265
Lysozyme	0.045	0.406
Gastric mucin	0.039	0.318

following: glycine, arginine, lysine, histamine, tryptamine, ethanolamine, gelatin, egg albumin, lysozyme, and gastric mucin at concentrations of 1 to 2 mg/ml (9).

RICHARD F. KEELER
Montana Veterinary Research Laboratory,
Montana State College, Bozeman

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3. The method used was modified from a standard Elson-Morgan (1) reaction as follows: Acetylacetone reagent was made by adding 1 ml of acetylacetone to 50 ml of 1N Na₂CO₃ and was used in place of the standard acetylacetone reagent. To 1-ml aliquots of the materials to be tested was added 1 ml of the acetylacetone reagent. After mixing, the tubes were capped and placed in a steam bath for 15 minutes, then cooled. Ethanol (7 ml) and Ehrlich reagent (1 ml) (1) were added and then mixed. Readings of optical density were taken after 30 minutes at 530 mμ in a Coleman spectrophotometer.
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8. The following two reagents were prepared immediately before use: acetylacetone dip (50 ml of acetone and 4 ml of acetylacetone) and Ehrlich dip (50 ml of 9/1 acetone/HCl (vol./vol.) and 0.5 g of dimethylaminobenzaldehyde). The strip was dipped in the former and heated for 5 minutes at 100°C, and then dipped in the latter and dried in the air.
9. This report is a contribution from the Montana Veterinary Research Laboratory (Montana Experiment Station and Livestock Sanitary Board cooperating), Montana State College, Agricultural Experiment Station, paper No. 441, journal series.

16 March 1959

Mutagenic Effect of Oxygen on Barley Seeds

Abstract. Resting barley seeds stored under oxygen at a pressure of 100 lb/in.² for 4 and 6 weeks exhibit a significant number of chromosome aberrations and mutations. The amount of cytogenetic damage increases with length of storage. The frequencies and types of changes are similar to those induced by 500 r to 1000 r of x-rays.

During experiments (1) on the relation of oxygen to the aftereffects of x-irradiation in barley seeds, a distinct mutagenic action of oxygen was found. In 1957 resting seeds of barley (*Hordeum vulgare*, variety Himalaya) were stored for 6 weeks under oxygen and under nitrogen; both gases were at 100-lb/in.² pressure. Other seeds were stored in oxygen and in argon at the same pressure for 4 weeks in 1958. Unstored seeds provided the controls. The moisture content of the seeds was maintained at 8 percent throughout the experiments by the pres-

Table 1. Frequencies of chromosome aberrations and seedling chlorophyll mutations induced in seeds of barley by oxygen, nitrogen or argon, at 100-lb/in.² pressure.

Treatment	Chromosome aberrations					Seedling mutations		
	No. of cells	Bridges		Fragments		No. of plants	No.	No. per plant
		No.	No. per cell	No.	No. per cell			
Experiment 1*								
Oxygen	300	12	0.040†	28	0.093†	468	20	0.04†
Nitrogen	400	2	0.005	14	0.035	468	4	0.008
Control	400	2	0.005	8	0.020	468	2	0.004
Experiment 2‡								
Oxygen	600	9	0.015	28	0.047†	803	14	0.017†
Argon	600	2	0.003	12	0.020	774	3	0.004
Control	600	3	0.005	9	0.015	761	1	0.001

* 1957 experiment; 6-wk storage period (summary of four replications). † Significant at the 5-percent level.

‡ 1958 experiment; 4-wk storage period (summary of seven replications).

ence of calcium chloride in the storage chambers.

Dicentric bridges and acentric fragments were scored in the shoot tips of M₁ seeds, and seedling chlorophyll mutations were recorded in the M₂ populations. Details of the storage, cytological, and mutation techniques have been published elsewhere (2). Because of the method used in gathering the data, it was theoretically possible to obtain numbers larger than 100 percent; however, in the data presented in this paper the numbers are well below 100 percent; therefore differences between means were tested for significance by the method and tables of Davies (3) designed for percentage data.

Significant increases in chromosome aberrations and mutations were found following the oxygen treatment in both experiments (Table 1). Neither the argon nor the nitrogen treatments differed significantly from the control treatments. Thus it appears that pressure alone is not mutagenic.

The difference in the number of chromosome aberrations and mutations between the two experiments is considered to be due to the length of time of storage. In the first experiment the barley seeds were under oxygen for 6 weeks, and in the second experiment for only 4 weeks.

Previous reports have recorded either chromosome aberrations or mutations induced by oxygen in biological material. Conger and Fairchild induced chromosome aberrations in *Tradescantia* pollen by high oxygen pressure (4). Since the present study was initiated, high oxygen pressure has been reported to induce mutations in *Escherichia coli* (5) and chromosome aberrations in seeds of barley (6) and *Crepis capillaris* (7).

The frequencies of chromosome aberrations and mutations in oxygen-treated seeds are similar to those induced by 500 r and 1000 r of x-rays (8); furthermore, the types of changes induced by

both mutagens are similar. These results support the postulate of Gerschman et al. (9) that a common mechanism may be operating in the biological effects of oxygen and x-irradiation.

It is well known that cytogenetic changes occur in aged seeds, although the cause of these changes is not well understood (10). The demonstration of the mutagenic action of oxygen in seeds may aid in understanding this process. Over a prolonged storage period, the atmospheric oxygen may directly or indirectly cause the chromosome breaks and mutations that arise in aged seeds. Furthermore, the results described in the present paper are providing an understanding of the relationship of oxygen to post-x-irradiation damage and to the indirect effects of x-rays in seeds.

W. E. KRONSTAD

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Department of Agronomy,
State College of Washington, Pullman

References and Notes

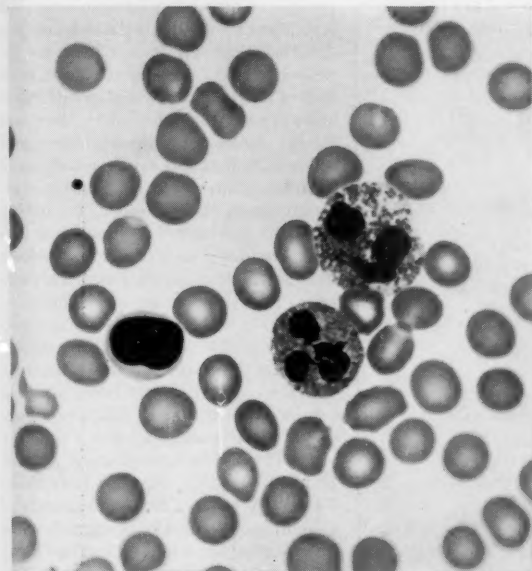
1. This research was supported by Washington Agricultural Experiment Stations (projects 1002 and 1068), U.S. Atomic Energy Commission contract AT(45-1)-353, U.S. Public Health Service grant A-2184, and funds provided for medical and biological research by State of Washington Initiative Measure 171.
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24 December 1958

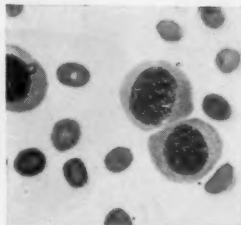
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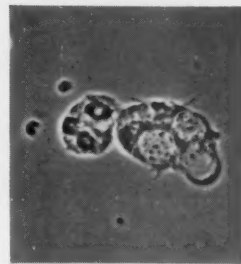
The sanguinary details



Among the red cells, three of the principal types of white cells, left to right: a lymphocyte, representing about 30% of the white cells; a neutrophil, representing 60%; an eosinophil, representing about 2%.



Megaloblastic cells, characteristic of the pattern of red cell maturation in pernicious anemia.

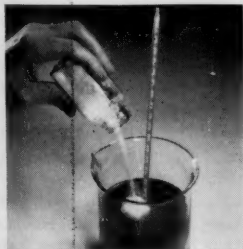


Erythrophagocyte, seen in an uncommon blood condition, where white cells swallow red cells. Here is one that has eaten three.

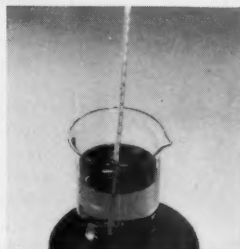
The objective documentation of hematological observations through properly controlled photomicrography is treated with some depth in the current issue of our periodical *Medical Radiography and Photography*. It contains some excellent color photomicrographs, including a series which depicts the maturation of human blood cells. However, if we were to go to the expense of reproducing the color on this page, it would use up money better spent in face-to-face instruction in hematological photomicrography for those who need it. You can look at the color all you want to by requesting a copy of the blood issue of *M. R. & P.* from Eastman Kodak Company, Medical Sales Division, Rochester 4, N. Y.

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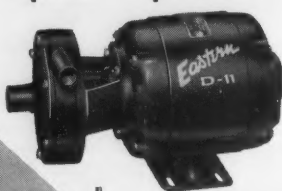
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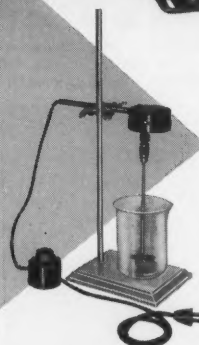
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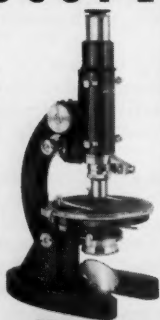
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Meetings

Science Congress at Singapore

The University of Malaya, at Singapore, was host to an international biological congress held at the university on 2-9 Dec. 1958. The congress was in celebration of the centenary of the formulation of the theory of evolution by Charles Darwin and Alfred Russel Wallace, and the bicentenary of the publication of the tenth edition of the *Systema Naturae* of Linnaeus. Singapore was a particularly appropriate site for such a meeting, since this city served Wallace as a base of operations during his 6-year sojourn in Malaya, when he formulated his concept of the mechanism of evolution.

Guests from 12 countries, representing four of the five continents, participated in the program, which lasted a full week. Sunday was taken up with conducted field trips to places on Singapore Island of special interest to biologists. The official guests were J. B. S. Haldane (Indian Statistical Institute, Calcutta), G. S. Carter (University of Cambridge), and H. G. Andrewartha (University of Adelaide). The Royal Society of London was represented by E. J. H. Corner, the British Association for the Advancement of Science by H. Munro Fox, the Zoological Society of London by R. D. Purchon, and the Institute of Biology by J. R. Audy. Purchon was chairman of the organizing committee, and Roland Sharma was general secretary.

Haldane served as president of the congress, and his presidential address, "The Theory of Natural Selection Today," provided the keynote of the program. After affirming that, after a hundred years, the concept of natural selection as an agent in evolution is more firmly established than ever, Haldane suggested that "the next great step in biology, comparable to those we are celebrating today, may be made—or may already have been made—in a tropical country." He further suggested that "the lack of complicated apparatus may even stimulate us to look at what is before our eyes."

A total of 68 papers was presented, under the general categories of evolution, parasitology and entomology, zoogeography, terrestrial ecology, freshwater ecology, genetics, anthropology, systematics, and botany. Emphasis throughout was on evolution (especially on those aspects of evolution that can best be studied in the tropics) and on tropical ecology, especially as it affects human welfare and well-being. The necessity for understanding the ecology of the tropics—so different in many ways and so much more complex than the ecology of temperate zones—if man is to avoid disaster in his attempts to manage

tropical nature was repeatedly stressed by speakers and discussants. The University of Malaya proposes to issue a volume containing the papers read at the congress. Abstracts of the papers have already been published by the university.

Participants were given a choice of three tours to various parts of Malaya, each under the leadership of a staff member of the zoology department of the university; these enabled foreign visitors to see something of tropical biology firsthand. One tour, to the King George V National Park in north-central Malaya, was conducted by J. R. Hendrickson. The park contains 1700 square miles of virgin tropical rain forest, in which the visitors lived and worked for a week; emphasis was on tropical terrestrial ecology. A second tour, along the west coast of Malaya as far north as Penang, which was led by D. S. Johnson, explored the various types of fresh waters in Malaya and studied tropical fresh-water ecology. A third tour, to Raffles Light in the Straits of Singapore, led by R. E. Sharma, studied tropical marine ecology.

It was generally agreed that the congress was an outstanding success. It was well organized and efficiently run, and it emphasized problems that are pertinent to the tropics in general and to Southeast Asia in particular. The papers presented were of the highest calibre. In view of the fact that the University of Malaya is only 9 years old, the centenary and bicentenary congress was nothing short of a triumph.

D. DWIGHT DAVIS

Chicago Natural History Museum,
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American Statistical Association

The 119th annual meeting of the American Statistical Association will be held in Washington, D.C., 27-30 December, with headquarters at the Shoreham Hotel. The 4-day meeting will have more than 50 technical sessions covering the methodology and application of statistics in many different professional fields. The sessions are sponsored and organized by the five sections of the American Statistical Association—Biometrics, business and economic statistics, physical and engineering sciences, social statistics, and training—and by the Institute of Mathematical Statistics. This meeting will be joint with a number of other societies, among them the American Economic Association, the American Finance Association, the Biometric Society (ENAR), and the Institute of Mathematical Statistics.

Further information regarding the preliminary program and other details will be available from the American Statis-

tical Association office, 1757 K St., NW, Washington 6, D.C., later this year. The program will be under the general chairmanship of Charles D. Stewart, Deputy Assistant, Secretary of Labor, U.S. Department of Labor, Washington, D.C.

Animal Cell Biology

The fourth annual Conference on Quantitative Study of Animal Cell Biology in vitro will be conducted by the department of biophysics of the University of Colorado, 31 August-3 Septem-

ber. The course is sponsored by the Colorado division of the American Cancer Society and is open to persons with the doctorate degree who are doing research or graduate teaching in biology and medicine, and to students who are currently enrolled as candidates for the Ph.D. degree in biological disciplines.

Lectures and laboratory demonstrations illustrating the basic techniques will be presented, but major emphasis this year will be placed on application of the quantitative methodologies to problems in mammalian cell genetics and chromosome analysis, biochemistry,



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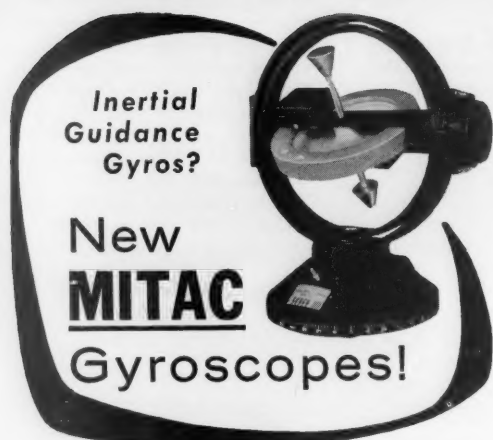
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virus-host cell interaction, and radiation studies. Possible uses of these methods in clinical medicine will also be considered. Participants should possess acquaintance with the principles of sterile technique and with the philosophy of quantitative microbiology.

Because requests for admission have in the past always exceeded the available facilities, applicants, up to the limit of 50, will be accepted in order of receipt of their completed applications. Inquiries should be addressed to the Department of Postgraduate Medical Education, University of Colorado Medical Center, 4200 E. 9th Ave., Denver 20, Colo.

Mammalogists to Meet

The American Society of Mammalogists will meet 22–24 June in Washington, D.C. Sessions will be held at the U.S. National Museum Auditorium, and meeting headquarters will be at the Harrington Hotel. The program will include technical papers that cover a diversity of basic mammalogical and ecological studies carried on throughout North America. Special tours are scheduled to the Fish and Wildlife Service's Patuxent Research Refuge in Maryland and the National Zoological Park. A

banquet and a program of outstanding documentary films are planned for the evening of 23 June at the Cosmos Club. Further information may be obtained from Viola S. Schantz, General Chairman, United States National Museum, Washington, D.C.

Symposium on Hematin Enzymes

Under the auspices of the International Union of Biochemistry, a symposium on hematin enzymes is to be held in Canberra, Australia, between 31 August and 4 September 1959. The symposium is being arranged by the Australian Academy of Science, and participation is by invitation.

About 40 scientists are expected to attend. Papers will be concerned with aspects of the following topics: the biogenesis and metabolism of heme compounds; the chemistry of hemoproteins, regarded as iron complexes, and as proteins; cytochromes and cytochrome oxidase; catalases and peroxidases; the respiratory chain and cellular organization; and problems of classification and nomenclature of cytochromes. The proceedings of the symposium are to be published by Pergamon Press in a special volume.

The costs of this meeting are being

borne by the Australian Academy of Science, the International Union of Biochemistry, and the Wellcome Trust. Travel of some overseas participants is being supported by the appropriate organizations in their respective countries.

A meeting of the Cytochrome Subcommittee of the I.U.B. Commission on Enzymes is to be held in the week following the symposium.

Professor R. K. Morton, Department of Agricultural Chemistry, University of Adelaide, South Australia, is convener of the organizing committee of the symposium.

Infrared Symposium

Some 300 scientists are expected to gather on 30 June at the University of Michigan, Ann Arbor, for the 44th Infrared Information Symposium. Representing industry, government, and academic institutions, they will hear presentations concerning infrared reconnaissance equipment, interpretation methods, and new concepts. The meeting will deal mainly with reconnaissance.

Attendance is by invitation; only those persons with a security clearance and a "need to know" will be admitted. The symposium is one of a continuing series of classified meetings on military appli-

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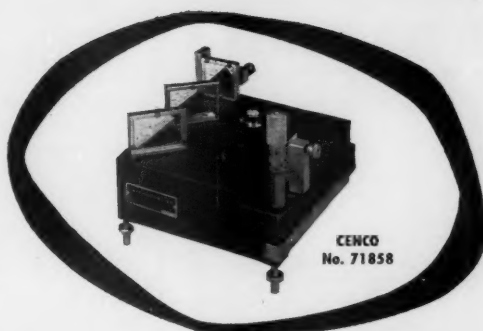
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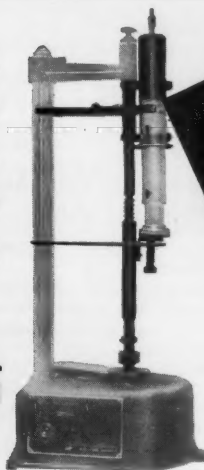


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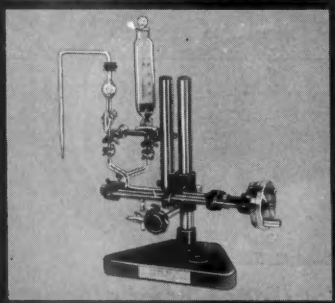
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cations of infrared techniques. It is sponsored by the Office of Naval Research and is conducted under joint direction of the military services.

Thomas B. Dowd of the Office of Naval Research, Boston (495 Summer St.), is in charge of invitations. Program chairman is William L. Wolfe, head of the Infrared Information and Analysis Center at the University of Michigan's Willow Run Laboratories.

Biology Teaching

The College Entrance Examination Board Conference on Advanced Placement in Biology will take place 25-27 June at Chatham College, Pittsburgh, Pa. Collegiate and secondary-school administrators and faculty will participate in workshop sessions on the instruction of able students especially interested in biology, and will hear talks on biology curricula and teaching. In addition to a representative from the College Entrance Examination Board program in advanced placement, speakers will include Oswald Tippo, Eaton professor of biology and director of the Marsh Botanical Garden, Yale University.

The conference is open to all interested educators. Information and application blanks may be obtained by writing to the conference chairman, Dr. Phyllis C. Martin, Chairman of the Department of Biological Sciences, Chatham College, Woodland Road, Pittsburgh 32, Pa.

Forthcoming Events

July

12-17. American Waterworks Assoc., annual conv., San Francisco, Calif. (H. E. Jordan, AWA, 521 Fifth Ave., New York 17.)

13-17. National Assoc. of Power Engineers, natl. conv., Boston, Mass. (A. F. Thompson, Secretary, NAPE, 176 W. Adams St., Chicago, Ill.)

13-17. Plastic Surgery, 26th intern. cong., London, England. (D. Matthews, Organizing Secretary, Intern. Cong. on Plastic Surgery, c/o Inst. of Child Health, Hospital for Sick Children, Great Ormond St., London, W.1.)

13-17. Standardization, intern. (council meeting), Geneva, Switzerland. (ISO, 1-3, rue Varembe, Geneva.)

15. American Soc. of Facial Plastic Surgery, New York, N.Y. (S. M. Bloom, 123 E. 83 St., New York 28.)

15-17. Fluorine Chemistry, symp., Birmingham, England. (Chemical Soc. of London, Burlington House, Piccadilly, London, W.1.)

15-17. Shaft Sinking and Tunnelling, symp., Olympia, London, England. (Institution of Mining Engineers, 3, Grosvenor Crescent, London, S.W.1.)

15-18. British Assoc. of Urological Surgeons (members and guests), Glasgow,

Scotland. (Joint Secretariat, 45, Lincoln's Inn Fields, London, W.C.2, England.)

15-18. British Cong. of Obstetrics and Gynaecology, 15th, Cardiff, Wales. (BCOG, Maternity Hospital, Glossop Terrace, Cardiff.)

15-24. British Medical Assoc., Edinburgh, Scotland. (BMA, Tavistock Sq., London, W.C.1, England.)

16-24. Canadian Medical Assoc., 92nd annual meeting in conjunction with the British Medical Assoc., Edinburgh, Scotland. (A. D. Kelly, CMA, 150 St. George St., Toronto 5, Ontario, Canada.)

17. High Energy Nuclear Physics, 9th annual intern. conf. (Intern. Union of Pure and Applied Physics, Moscow, U.S.S.R.). (R. E. Marshak, Univ. of Rochester, Rochester, N.Y.)

19-24. American Crystallographic Assoc., Ithaca, N.Y. (J. Waser, Rice Inst., Houston 5, Tex.)

19-25. Pediatrics, 9th intern. cong., Montreal, Canada. (R. L. Denton, P.O. Box 215, Westmount, Montreal 6.)

20-26. Radiation and Atmospheric Ozone, joint symp., by Intern. Union of Geodesy and Geophysics and World Meteorological Organization, Oxford, England. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva, Switzerland.)

22-23. Rocky Mountain Cancer Conf., Denver, Colo. (N. Paul Isbell, 835 Republican Bldg., Denver 2.)

23-30. Radiology, 9th intern. cong., Munich, Germany. (Sekretariat des 9 Internationalen Kongresses für Radiologie, Reitmorstrasse 29, Munich 22.)

26-30. International Psychoanalytical Assoc., Copenhagen, Denmark. (Miss P. King, 37 Albion St., London, W.2.)

27-4. International Federation of Translators, Bad Godesberg, Germany. (Dritter Internationaler FIT-Kongress, Kongress Sekretariat, Bundesverband der Dolmetscher und Übersetzer e. V. (BDÜ) Hausdorffstrasse 2, Bonn, Germany.)

30-31. Computers and Data Processing, 6th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst., Univ. of Denver, Denver 10, Colo.)

August

1-8. World Congress of Esperantists, 44th, Warsaw, Poland. (Office of Intern. Conferences, Dept. of State, Washington 25.)

4-5. American Astronautical Soc., 2nd annual western, Los Angeles, Calif. (A. P. Mayernik, AAS, 6708 53 Rd., Maspeth 78, N.Y.)

6-8. Human Pituitary Hormones, colloquium (by invitation only), Buenos Aires, Argentina. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Place, London W.2, England.)

9-12. American Soc. of Mechanical Engineers (Heat Transfer Div.), conf., Storrs, Conn. (D. B. MacDougall, ASME, 29 West 39 St., New York 18.)

9-15. Physiological Sciences, 21st intern. cong., Buenos Aires, Argentina. (C. F. Schmidt, Univ. of Pennsylvania School of Medicine, Philadelphia 4.)

10-13. National Medical Assoc., Detroit, Mich. (J. T. Givens, 1108 Church St., Norfolk, Va.)

(See issue of 15 May for comprehensive list)

Vol. 10 June 1959 Approx. 492 pages

ANNUAL REVIEW OF PLANT PHYSIOLOGY

Prefatory Chapter
Foliar Absorption of Mineral Nutrients
Leaf Proteins
Light-Induced Reactions of Bacterial Chromatophores and Their Relation to Photosynthesis
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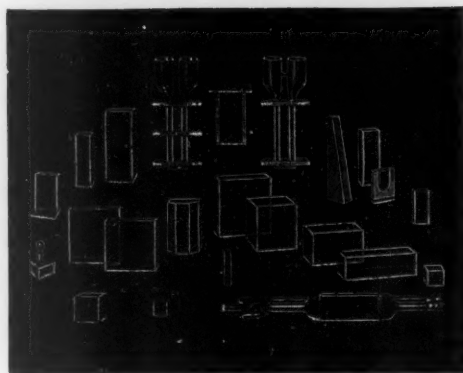
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New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 1630.

■ **CORE TESTER** for automatic grading of ferrite memory cores 0.080 in. in diameter operates at a maximum rate of 3600 cores per hour. The tester provides for separation of the tested cores into five grades. The core to be tested is automatically positioned to be carried into two sets of contacts. Programmed pulses are applied to the core by one set of contacts, while the second set picks up induced voltage output. The response can be examined by the operator or by an automatic decision-making circuit. (Rese Engineering Inc., Dept. 854)

■ **TRITIUM SURVEY METER** continuously monitors atmospheric and surface radioactive contamination from tritium, carbon-14 and other low-energy beta emitters. The instrument uses a flow-through ionization chamber, a continuous air-intake system, and an electrometer amplifier. A "sniffer" hose permits spot-check monitoring. The instrument's front panel meter is calibrated to read directly in microcuries of tritium per cubic meter of air. A warning alarm and connections for operation of a 100-mv recorder are included. (Atomic Accessories Inc., Dept. 862)

■ **LABORATORY CHEMICAL CATALOG** of British drug houses provides 336 pages of information about 6500 organic and inorganic chemicals, solutions for analytical use, indicators, microscopical stains, resins, dyes, and so forth. (Ealing Corp., Dept. 863)

■ **PRESSURE TRANSDUCER** that converts pressure to frequency combines a reactance-controlled subcarrier oscillator and a single-coil, variable-reluctance pressure pickup. The oscillator and pickup are closely matched, and nonlinearity does not exceed ± 1 percent. Since the pressure-sensitive diaphragm is the only moving part, the transducer is resistant to shock vibration and acceleration. (Ultradyn, Inc., Dept. 866)

■ **POWER SUPPLY** provides output from 500 to 2500 v at 0 to 10 ma d-c. Polarity is reversible, and current and voltage meters are provided. Regulation against line voltage fluctuations is said to better than ± 50 parts per million, ripple less than 10 parts per million, and load regulation better than ± 60 parts per million over the entire output range. The instrument uses printed circuits. (NJE Corp., Dept. 873)

■ **PULSE-HEIGHT ANALYZER** consists of a single-channel analyzer containing a non-overloading linear amplifier, an electronic sweep-count-rate-meter, a high-voltage supply, and a strip-chart recorder. The electronic sweep circuit is used to scan the spectrum between any two predetermined levels from 0 to 85 v. The scan is performed automatically; after each scan the device resets and repeats the cycle. An automatic sample-changer accessory can be used to change the sample at the time of reset. (Radiation Instrument Development Lab. Inc., Dept. 869)

■ **DIFFERENTIAL TRANSFORMERS** are able to operate continuously at 1000°F and to withstand 2000°F for periods up to 5 min. The two models available are designed to measure displacements up to ± 0.150 and ± 0.500 in. respectively. Coils are wound on ceramic bobbins, and leads are terminated on lugs. Lead wires are up to 3 ft long. (Automatic Timing & Controls, Inc., Dept. 864)

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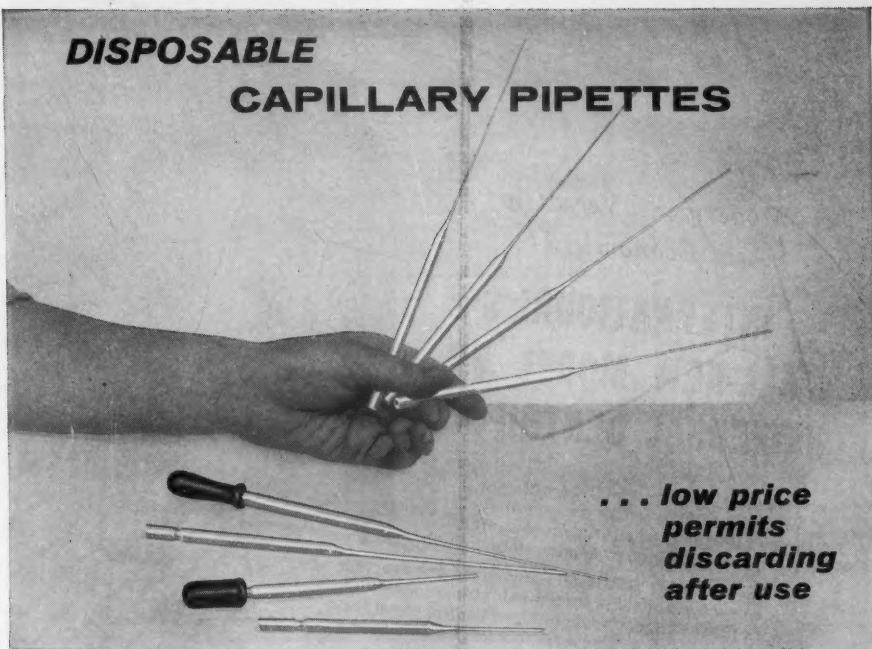
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